OPERATIVE SURGERY

COVERING

THE OPERATIVE TECHNIC INVOLVED IN
THE OPERATIONS OF GENERAL AND SPECIAL SURGERY

By

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OPERATIVE SURGERY

CHAPTER LVI

OPERATIONS UPON THE PERICARDIUM

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SURGICAL ANATOMY OF THE PERICARDIUM

Position.—Occupies the middle mediastinum of the thorax, lying between the anterior mediastinum, in front (opposite the sternum and third, fourth, fifth, sixth, and seventh costal cartilages) — the posterior mediastinum, behind — and the pleuræ, laterally. Consists of visceral and parietal layers. Has general outline of the heart, except where reflected on to the great vessels at the base of the heart.

Attachments.—**Apex;** covers the great vessels for about 5 cm. (2 inches) and is held in position by them. **Base;** attached to the central tendon of the diaphragm and adjacent surface. **Anterior surface of the pericardium;** attached to the posterior surface of the manubrium and ensiform process by the superior and inferior sternopericardial ligaments.

Relations.—**Superiorly;** great vessels of heart. **Inferiorly;** diaphragm. **Anteriorly;** thymus gland (or remains); areolar tissue; margins of lungs (especially left); sternopericardial ligaments; triangularis sterni muscle; internal mammary vessels; anterior mediastinum; sternum. **Posteriorly;** bronchi; esophagus; descending aorta; pneumogastric nerves; posterior mediastinum. **Laterally;** pleuræ; anterior margins of lungs (especially left); phrenic nerves; accompanying phrenic vessels.

Structures Covered by Pericardium.—Aorta; superior vena cava; pulmonary artery and bifurcations; ductus arteriosus; four pulmonary veins.

Arteries.—Pericardiac and musculophrenic from internal mammary; pericardiac, esophageal, and bronchial from descending aorta; coronary from ascending aorta; phrenic from abdominal aorta.

Veins.—Pass to azygos, internal mammary and phrenic trunks, cardiac veins emptying into right auricle.

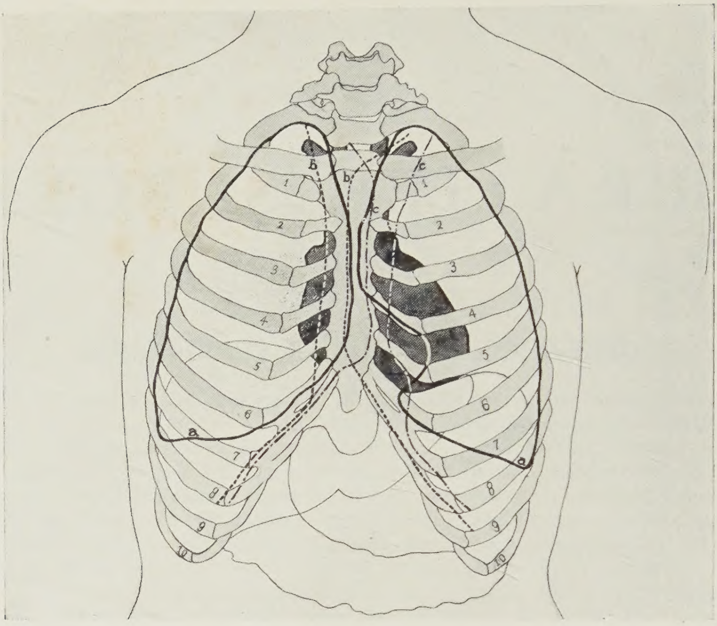

Fig. 3260.—VARIATIONS IN THE POSITIONS OF THE ANTERIOR MARGINS OF THE PLEURÆ IN RELATION TO THE HEART AND ADJACENT STRUCTURES: _ a, a, Normal outline of the right and left pleural borders anteriorly; _ b, b, variations of right and left pleural borders further to the right than normal; _ c, c, variations of both pleural borders farther to the left than normal. These variations are of practical importance especially in exposing the pericardium and heart

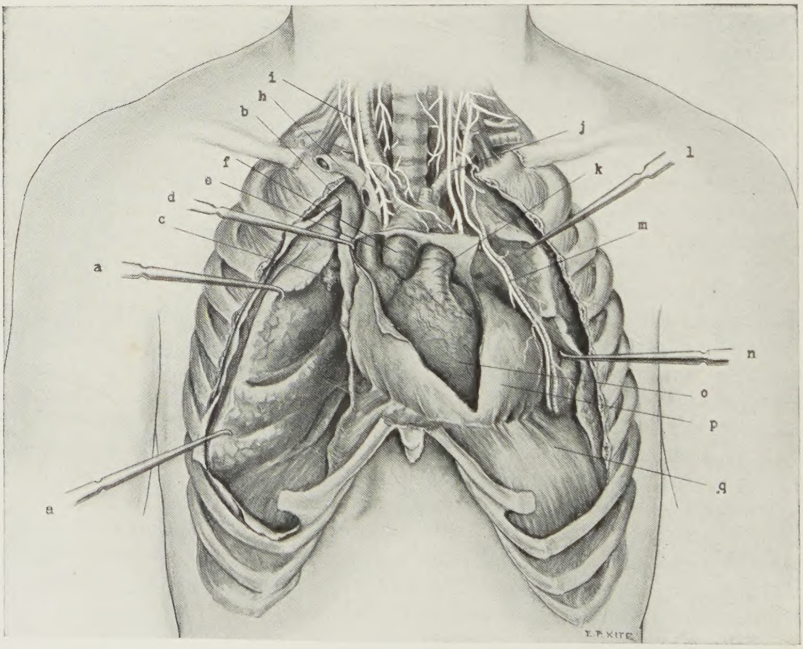

Fig. 3261.—RELATIONSHIPS OF THE PERICARDIUM, HEART, INTRAPERICARDIAL VESSELS, LUNGS, AND ADJACENT STRUCTURES: _ a, a, Retracted right lung, whose pleura has been incised, as seen at **b**; _ **c**, structures of the hilum of the right lung; _ **d**, incised pericardial sac, displaced outward; _ **e**, superior vena cava; _ **f**, aorta; _ **k**, pulmonary artery; _ **h**, right innominate vein; _ **i**, right pneumogastric nerve; _ **j**, left pneumogastric nerve; _ **l**, **n**, left lung, displaced outward, its pleura unopened; _ **m**, left phrenic nerve and cardiophrenic vessels; _ **o**, heart; _ **p**, pericardium; _ **q**, diaphragm. (Composed from various Anatomies.)

Nerves.—Branches from pneumogastric, phrenic, and sympathetic.
Lymphatics.—Empty into mediastinal glands.

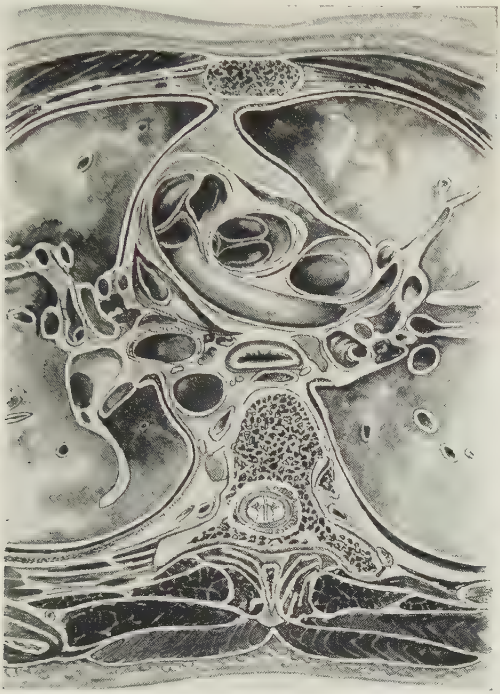

Fig. 3262.—Sectional View of the Heart and Pericardium at the Level of the Sixth Thoracic Vertebra; – Showing the sinus costomediastinalis – anterior mediastinal space – and adjacent structures. (Modified from Brauné.)

The superficial and deep relations of the heart and pericardium are shown in Figs. 3260–3262.

SURFACE FORM AND LANDMARKS OF THE PERICARDIUM

The anterior surface of the upper portion of the pericardium is from 3 to 5 cm. (about $1\frac{1}{4}$–2 inches) posterior to the sternum—and the anterior surface of the lower portion is about 1 cm. (about $\frac{3}{8}$ inch) posterior to the sternum.

Normally there is a collapsed culdesac at the base of the anterior portion of the pericardium, which is much distended in effusion. This is the site sought in drainage.

According to Voinitch-Sianojentsky, the interpleural pericardial area extends vertically from the lower border of the left fifth chondrosternal articulation to the left seventh chondrosternal articulation—lying mainly behind the sternum but also corresponding to the sternal end of the sixth intercostal space—wherefore, puncture of the pericardium in the sixth space may be made directly inward—whereas it should be directed very obliquely downward if made in the fifth interspace, to avoid the heart (that is, it runs parallel with the heart after entering the pericardium).

A cartilaginous bridge unites the sixth and seventh costal cartilages—

and sometimes also the fifth and sixth – and thereby the intercostal area for puncture, between the inner border of the cartilaginous bridge and the left border of the sternum, may be considerably encroached upon.

The internal mammary artery runs down at an average distance of about 1.2 cm. (about $\frac{1}{2}$ inch) to the outer side of the sternal border – to the sixth interspace, where it divides into the superior epigastric and the musculophrenic.

For outline of Pleura, see Anatomy of Pleura. and Fig. 3260, illustrating variations in its position.

PERICARDIOCENTESIS, OR PARACENTESIS PERICARDII

Description.—Puncture of the pericardium consists in the penetration of the pericardium by a hollow needle attached to a vacuum-syringe, for the purpose of withdrawing pericardial contents. It is chiefly used for diagnosis – sometimes, therapeutically, for the withdrawal, in bulk, of the fluid in hemopericardium and in hydropericardium. In pyopericardium, pericardiotomy should be performed, rather than pericardiocentesis.

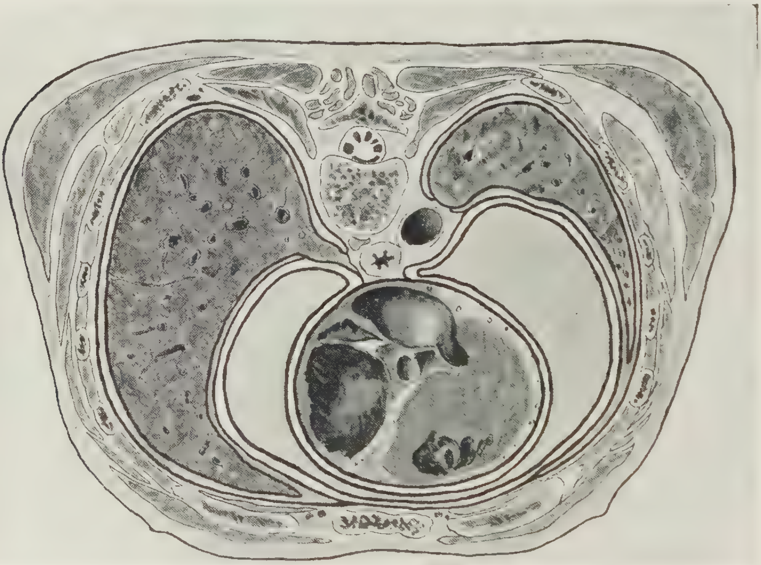

Fig. 3263.—Position of Heart and Pericardium in Pericardial Distention – seen in sectional view. (Modified from Kocher.)

Ferrand and Voinitch-Sianojentsky have shown that in non-adherent pericarditis heart fluid accumulations within the pericardium tend to collect between the heart and the pericardium, mainly anteriorly and in the region of the apex, when the patient is sitting or standing – and between the thoracic wall and the anterior aspect of the heart, toward the base of the heart and in the region of the large vessels, when the patient is in the recumbent posture (Fig. 3263). These circumstances make it possible to puncture the pericardium without wounding the heart.

Preparation.—The region is usually shaved.

Analgesia is usually employed.

Position.—Patient supine, preferably resting upon some object which will render chest prominent and increase the width of the intercostal spaces. Surgeon on left of patient. Semirecumbency is sometimes preferred.

Sites of Puncture.—Puncture may be made in either the fifth or sixth interspace _ and either internal to or external to the internal mammary artery (Fig. 3264). In the fifth interspace, the width is greater near the sternal border, and is the space usually chosen. In the sixth interspace, the internal mammary artery and the pleura are both further from the left sternal border, and puncture may be made more directly inward. Where sufficient width of space exists, the sixth interspace should be chosen. Puncture should, by preference, be made internal to the internal mammary artery, as the pleura is in less danger of injury, especially in the fifth space _ and even in the sixth space, the puncture would have to be about 2.5 cm. (about 1 inch) outside of the border of the sternum to be sure of being external to the internal mammary artery, and then it is apt to strike the pleura.

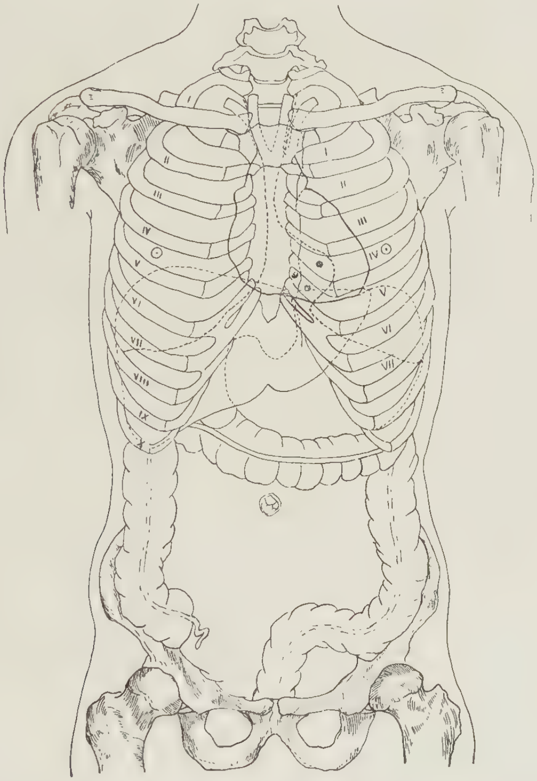

Fig. 3264.—Sites for Pericardiocentesis; _ The uncovered area of the heart and the course of the internal mammary artery are shown. Paracentesis is preferably made to the inner side of the internal mammary artery, in the sixth (by choice) or fifth intercostal space, close to the margin of the sternum _ or to the outer side of the artery, in the fifth or fourth interspace, from 2.5 to 5 cm. (1–2 inches) outside of the sternal border. (Thorax modified from Deaver.)

Landmarks.—Fifth left intercostal space (or sixth); left margin of sternum; course of internal mammary artery; anterior border of left lung and pleura: right border of heart. See the Surgical Anatomy of these structures.

Operation.—An incision should be made in the long axis of the sternal end of the fifth intercostal space, through skin, fascia, pectoralis major, down to the intercostal membrane, clamping all bleeding vessels. Expose the intercostal membrane by retraction of the edges of the wound.

Grasping the needle with right forefinger and thumb, so placed as to prevent its suddenly entering too far, pierce the fifth intercostal space near the left border of the sternum, and near the upper border of the sixth costal cartilage _ penetrate straight backward about 0.8 cm. (about $\frac{5}{16}$ inch), which is, approximately, the thickness of the sternum _ then penetrate inward toward the posterior surface of the sternum for 1 to 2 cm. ($\frac{3}{8}$ to $\frac{13}{16}$ inch), to avoid the possible forward extension of the pleura _ thence penetrate downward and inward through the pericardium _ the sensation generally indicating when the pericardium is entered. Briefly stated _ pass backward, inward, and downward (Delorme and Mignon).

Where the sixth intercostal space is used, the needle is passed directly inward and backward, close to the sternum and in the middle of the interspace (Voinitch-Sianojentsky).

Comment.—Puncture may be made without previous incision, but preliminary incision is better, as the intercostal space and border of the sternum are exposed, and the course and depth of the needle and entrance into the pericardium are better appreciated. Also the bridge of cartilage across the intercostal space, when present, may be avoided. There is less danger of wounding the heart in the sixth interspace.

While it is usually possible to puncture the pericardium through one of the intercostal spaces, near the lower aspect of the sternum, without damaging the pleuræ, yet, because of the variations of the pleural margins toward the median line, there is no great likelihood of injuring these structures. Although it is supposed that when the pericardium is distended, the pleural margins are correspondingly pushed outward, there seems to be no certainty of this. It is of considerable importance that the pleura should not be wounded, if there be question as to the septicity of the fluid to be aspirated.

Burghard advises making the pericardiocentesis in the fifth left intercostal space, $\frac{3}{4}$ inch from the sternum _ the trocar (which he prefers to the needle) is passed backward and to the right. In puncturing in the right fifth interspace, $\frac{3}{4}$ inch from the sternum, the instrument ranges backward and to the left.

If a needle be used, it should have a rounded, short point _ and the flow of fluid should be immediately recognized, that its progress may be arrested and the heart not wounded.

Pericardiocentesis is generally indicated in non-suppurative cases (certainly as the first puncture) _ and pericardiotomy, in suppurative cases requiring free opening and drainage.

Penetration of the free margins of the pleura would ordinarily be of no consequence, provided one were certain that the fluid to be aspirated were non-infective. Then, too, in cases where pericardiocentesis is likely to be indicated, both surfaces of the free margin (parietal and visceral) are also likely, or are often, found adherent, so that the general pleural cavity is shut off.

It is evident what a wide range of calculation one must make, if the extreme variations of pleuræ are to be considered _ as shown in Fig. 3260.

If it were possible to differentiate cardiac dulness from the dulness of pericardial effusion, it would be indicated to puncture below the dulness of the former.

The operator will be aided in securing accuracy and control of manipulation, if he steadies his hand by resting the fourth and fifth fingers upon the chest wall. And if the patient makes a full expiration at the moment of puncture, the margins of the pleuræ will additionally recede.

In coming into contact with the pericardium, some resistance is usually experienced, and penetration must cease the moment this is passed — the interpretation being that the pericardium has been punctured. If the needle should pass on and engage itself in the heart, this fact is generally transmitted to the operator by the movement of the puncturing instrument — which must, of course, be at once withdrawn sufficiently to disengage itself from the heart.

There are some very distinct advantages in using a trocar and cannula. One is, the trocar can be withdrawn as soon as the pericardium is entered, and then there will be no further danger of wounding the heart as the pericardium is emptied. If it be anticipated that suction will be necessary, some type of trocar and cannula may be employed, which admits of the adjustment of a suction-syringe to the cannula. On the other hand, a distinct disadvantage of the trocar and cannula is, that if the instrument has not entered the pericardium when the trocar is withdrawn, it can no longer be made to penetrate still further to find the distended pericardium, as the usual exploratory suction-syringe needle can — but must be entirely withdrawn, and reinserted — or the trocar replaced and pushed onward.

In therapeutic puncture-evacuation of the pericardium, the accumulated fluid is withdrawn slowly enough to avoid embarrassing the heart.

It would seem wisest never to undertake paracentesis pericardii, unless all the arrangements are previously made for possible immediate pericardiotomy — in the event that the exploratory needle demonstrates the presence of pus, instead of some non-septic fluid.

Matas lays stress upon a number of practical points in connection with pericardicentesis; — He prefers an extra-long hypodermic needle, not over 3 cm. ($1\frac{3}{16}$ inches) long — or a capillary trocar, not over $\frac{1}{2}$ millimeter in caliber, connected with a Potain aspirator — emphasizing the desirability of capillary puncture, with a needle but little larger than an ordinary hypodermic needle, with short point. As to the sites of puncture, he writes, "I would prefer the left xiphoid space, in the extreme upper edge of the chondro xiphoid angle, where the skin may be marked with a bistoury to show the juncture of the seventh left costal cartilage and the ensiform. A needle driven obliquely upward and backward at this point, so as to avoid the diaphragm, will reach the anterior pericardial culdesac, without touching the pleura or peritoneum at a depth of $\frac{1}{2}$ to 2 inches — which offers greater advantages and less risks than any other. Next to this, Voinitch's safety spot (junction of the sternum in the sixth left interspace). Then, if the needle fails at these two points — Rotch's point, in the fifth *right* intercostal space, 4 cm. (1.12 inches) outside of the border of the sternum." Terrier and Reymond advise, he states, the withdrawal of the needle, or trocar, whenever it fails to demonstrate fluid at a depth of 2.5 cm. (between 14/16 and 15/16 inches).

The dangers and accidents of paracentesis of the pericardium, mentioned by Matas, are the following: — (*a*) Dry puncture, — (*b*) Aspiration of pleural instead of pericardial fluid (just as the reverse may occur in pleuracentesis), — (*c*) Puncture of the heart — 9 deaths within two hours being reported, out of 11 occurrences of this accident, — (*d*) Puncture of the pleura — 3 cases of pleural infection being reported as a result, — (*e*) Wound of the lungs, — (*f*) Wound of internal mammary vessels, — (*g*) Sudden death, supposed to be due to emotional causes in patients with endocardial, or myocardial lesions, — 7 such instances being reported. Damage to the coronary vessels has also been reported, without the heart being otherwise injured.

PERICARDIOTOMY, IN GENERAL

Pericardiotomy, or incision of the pericardium, as an individual operation, is usually performed for the purpose of evacuating purulent pericardial fluid — for the establishment of drainage in connection with such evacuation — for exploration — and for the removal of foreign bodies, or the repair of wounds. Pericardiotomy, as an incidental procedure, is, of course, a step in every operation upon the heart proper — and in the operations upon the first part of the great vessels.

The methods of performing pericardiotomy are very many. Schwartz has classified them under four headings, with several procedures under each heading (twenty-one, in all, which will not be here separately mentioned): —

Classification of Routes and Methods of Pericardiotomy — (Schwartz): —

(*a*) Simple Incision of the Pericardium, without Bony Resection, —
    (1) By the thoracic route.
    (2) By the epigastric route, extraperitoneally.
    (3) By the epigastric route, intraperitoneally.
(*b*) Incision of the Pericardium, after Chondral Resection, —
    (1) Pericardiotomy after resection of a single cartilage.
    (2) Pericardiotomy after resection of two cartilages.
(*c*) Incision of the Pericardium, after Sternal Resection.
(*d*) Incision of the Pericardium, after Chondrosternal Resection.

Some of the operations which are most frequently employed for exposing the pericardium for the purpose of incision will be given in the following pages.

It is of practical importance to note there is a marked tendency toward the entire abandonment of the pericardial puncture, for any and all purposes, as a dangerous and blind procedure, at best — and the substitution of pericardial incision, as an open and much safer procedure, in all cases where the pericardium must be explored, or in any way invaded. Besides, it is definitely known (as proved by autopsy) that some pericardial effusions are postcardiac, and are not possibly evacuable through any puncture by needle, or trocar — as, of course, fluid confined behind the heart cannot be reached by puncture — but can be reached by the deliberate open incision of the pericardium, followed by exploration of the pericardial cavity.

The pericardium should be opened in a dependent position, which will offer easy escape for fluid from both sides of the pericardial cavity — and also afford satisfactory mechanical drainage — which is aided by the patient's being kept in a semirecumbent position.

Analgesia is distinctly preferable to anesthesia in these cases — where the heart is often embarrassed by the condition for which the operation is performed — and, additionally, may be involved by endocarditis or myocarditis. If the pericardium itself be analgesized in advance of handling and incising, serious reflex phenomena may be lessened or avoided.

PERICARDIOTOMY BY AN INCISION THROUGH AN INTERCOSTAL SPACE

Description.—The approach is here made through an intercostal, or, strictly, interchondral space — usually in the fifth left interchondral space (between the fifth and sixth costal cartilages) — and is generally resorted to for the purpose of drainage. The method, however, is distinctly inferior to the exposure of the pericardium after the excision of a costal cartilage (see the next operation), followed by the deliberate incision of the pericardium in a field far more satisfactory than is attainable in the average interchondral regions over the heart. It is conceivable that the procedure might, exceptionally, be undertaken in some abnormally wide interchondral space (such as sometimes encountered in deformities) _ or that the procedure might be the accidental ending of a technic begun as a puncture of the pericardium.

Preparation and Position.—As for Paracentesis Pericardii.

Landmarks.—Sternal end of left fifth intercostal space (between fifth and sixth rib cartilages); and other landmarks mentioned under Paracentesis Pericardii.

Incision.—Incision in center of fifth intercostal space, parallel with its long axis _ beginning at the left sternal border and extending 5 to 7.5 cm. (about 2–3 inches) in length. (See Fig. 3265, A.)

Operation.—Incise the skin, fascia, pectoralis major, external intercostal membrane, and internal intercostal muscle _ ligating all bleeding vessels. The internal mammary artery is either divided between two ligatures or, preferably, drawn outward. The triangularis sterni muscle is divided, or its fibers separated by blunt dissection. If the pleura be in the field, it will be exposed after passing through the triangularis sterni, and should be carefully displaced outward.

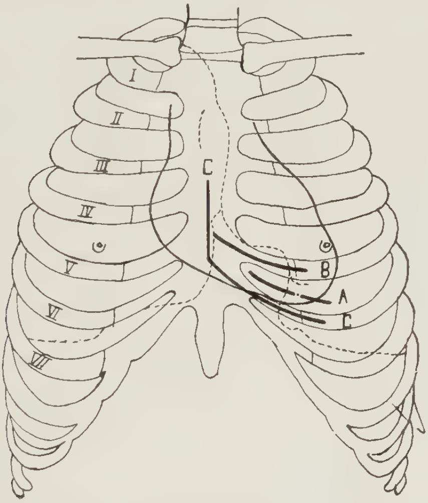

Fig. 3265.—Sites of Incisions for Pericardiotomy: _ A, Intercostal incision in fifth left interspace; _ B, incision for excision of fifth left costal cartilage; _ C, C, Kocher's sternocostal incision for excision of sixth and sometimes of fifth and fourth costal cartilages.

The pericardium is now within sight and touch _ and is carefully seized and steadied by two toothed forceps and incised for 1 to 2.5 cm. (about $\frac{1}{2}$ to 1 inch) between them, in a direction downward and outward from the border of the sternum. The edges of the pericardium are sutured into the deeper plane of the thoracic wound _ that is, at the opening through the internal intercostal muscle. Drainage is established from the interior of the pericardium through the lowest part of the outer wound, the upper portion of which may be closed.

Comment.—(*a*) The pericardium should be opened with scissors, and the opening increased by blunt-pointed scissors or probe-pointed knife. (*b*) Pericardiotomy may also be performed, but less safely, through the costoxiphoid angle (Larrey's space).

PERICARDIOTOMY THROUGH THE BED OF THE EXCISED LEFT FIFTH COSTAL CARTILAGE

Description.—After the subperichondrial excision of the left fifth costal cartilage, an incision is made into the thoracic cavity, through the perichondrium of the excised cartilage _ after which the pericardium is seized, brought into the wound, and incised. This is the most frequent route and method of procedure in incising the pericardium for drainage. If more room were required, as might be the case in making a more extensive exposure of the heart, the left fourth or sixth costal cartilages, or both, may also be excised. The cartilage may be excised subperichondrially or extraperichondrially.

Analgesia ; _ Anesthesia.—Either may be used _ the former being generally employed.

Preparation ; _ Position.—As for Paracentesis Pericardii.

Landmarks.—Left fifth costal cartilage; and other landmarks mentioned under Paracentesis Pericardii.

Incision.—Directly over the center of the fifth costal cartilage _ beginning over the center of the sternum and ending just beyond the chondrocostal articulation.

Operation.—Incise skin, superficial fascia, pectoralis major, and deep fascia directly down upon the full length of the fifth costal cartilage, ligating all vessels severed. Isolate the fifth costal cartilage from its neighboring structures (external intercostal membrane, internal intercostal muscle, and triangularis sterni, if any of the last be attached) as completely as possible, by hugging and clearing the cartilage closely. Divide its sternal and costal ends with blunt-pointed pliers _ or, preferably, with Gigli saw. Ligate the intercostal vessels at both ends of the wound and divide them between the ligatures. Divide tissues which intervene between the bed of the cartilage and the internal mammary artery. Cut the internal mammary artery between two ligatures, or draw it outward. Incise the triangularis sterni (Fig. 3267), if necessary, or separate it from the sternum and push it to the right. Displace the pleura outward, after careful separation from the pericardium and sternal structures.

The pericardium is now in the field, and is treated as indicated by the object of the operation _ In Pericardiotomy (for drainage) the pericardium is steadied between two toothed forceps and carefully incised obliquely downward and outward from close to the border of the sternum; _ In Pericardiorrhaphy (for incised wounds of the pericardium) the lips of the pericardial wound are approximated and so sutured with catgut as to bring the serous surfaces together. Where the pericardium has been incised for drainage, it is sutured into the lower plane of the outer wound _ that is, the triangularis sterni and internal intercostal muscles. The external wound is closed in greater part, and drainage provided from the interior of the pericardium through the part of the thoracic wound left open. Where the pericardium has been sutured, temporary drainage of the external wound only is instituted through a limited opening, the remainder of the thoracic wound being closed.

Comment.—(*a*) This may be considered the best manner of exposing the pericardium for drainage and the opening of the pericardium after free exposure may, ordinarily, be considered safer than puncture or aspiration through an unopened thorax. (*b*) Having excised the fifth costal cartilage by the above incision, if more room be required, or it be desired also to remove the fourth and sixth costal cartilages in addition, the object may be accomplished by making a vertical incision at the inner end of the original incision, down the center of the sternum, and another vertical incision at the outer end of the original incision. Where both the fourth and sixth costal cartilages are to be removed, these two vertical incisions will extend from above the fourth to just below the sixth cartilages, thus making an ⊢⊣-shaped incision, and enabling two flaps of soft parts down to the cartilages to be turned, the one upward, and the other downward. If it be desired to remove only the fourth cartilage in addition, then only the upper parts of the vertical incisions are added. If only the sixth cartilage must be additionally removed, then only the lower parts of the vertical incisions are used. If it be known from the start that two or more costal cartilages must be removed, an oval or modified horseshoe flap of soft parts with its base over the sternum and its convexity extending beyond the outer limit of the excision, may be used, _ or an **I**-shaped incision, the vertical portion being from 1 to 2 cm. (about $\frac{1}{2}$–$\frac{3}{4}$ inch) from the sternum, the transverse parts corresponding with the uppermost and lowermost ribs to be removed, may be used, the two flaps thus outlined being turned inward and outward. Additional room may always be gotten by resecting, with rongeur forceps, the left border of the sternum.

PERICARDIOTOMY (INCLUDING THE POSSIBLE EXPOSURE OF THE HEART), THROUGH THE BED OF THE EXCISED LEFT SIXTH COSTAL CARTILAGE, WITH OR WITHOUT THE TEMPORARY DISPLACEMENT OF THE FIFTH, FOURTH, AND THIRD COSTAL CARTILAGES BY A CHONDROPLASTIC FLAP _ THROUGH AN ANGULAR INCISION

KOCHER

Description.—The above title sufficiently explains the operation. Room enough for incision of the pericardium is ordinarily secured by excision of the sixth costal cartilage alone. If more room be required for further exposure of the heart, this may be secured by dividing the sternal end of one, two, or three cartilages next above, followed by the breaking back of their costal ends (deliberate section, as in making thoracoplastic flaps, would be better) _ after which the chondroplastic flap is temporarily turned outward.

Preparation ; _ Position.—As in the preceding exposures.

Analgesia ; _ Anesthesia.—The former usually suffices for the excision of a single cartilage. The latter would be indicated in proportion to the extent of the operation.

Landmarks.—The sternal contour, the left sixth and adjacent costal cartilages.

Incision.—The incision at first plans for the excision of the left sixth costal cartilage _ with provisional extensions for enlarging the field of operation, if found necessary. The vertical limb of the incision passes down the center of the sternum, to the level of the sixth interchondral space _ and may be extended upward as far as the second intercostal space. The oblique limb of the incision extends outward along the left sixth costal cartilage _ and may be extended as far as the mammary line (Fig. 3266).

Operation.—The skin incisions pass directly down through the periosteum of the sternum and the perichondrium of the sixth costal cartilage _ after which, by the careful manipulation of a curved periosteal elevator, the periosteum is stripped back from the sternum _ and the perichondrium from the costal cartilage _ the pectoralis major being included in the elevated soft parts. When the sixth cartilage has been cleared in its entire circumference, it is carefully divided, with bone-cutting forceps, close to the sternum _ as well as at its costal end _ and excised. If it be considered that this single excision does not give sufficient room, the sternal periosteum, together with the pectoralis major, may be stripped upward over a greater extent _ and the cartilages corresponding with the portion of the sternum further exposed, subperichondrially freed, and divided near the sternal border. In the oblique portion of the incision, the attachments of the pectoralis major and rectus abdominis are detached, along the upper border of the sixth rib _ and the aponeurosis of the external intercostal muscle, as well as the fibers of the internal intercostal, are raised together with the perichondrium, in the subperichondrial freeing of the sixth cartilage. The internal mammary artery and veins will be now exposed, through the incised perichondrial bed, lying upon the triangularis sterni muscle, which separate them from the pleura. The internal mammary vessels are now doubly tied, and divided. Occasionally, these vessels are retracted, instead of being tied _ dependent upon their disposition and interference. The tendinous attachments of the triangularis sterni to the sternum and to the perichondrium of the sixth costal cartilage are separated, or divided, with great care. The Surgeon's index-finger is now passed through the incised bed of the sixth cartilage, and between the separated attachments of the triangularis sterni _ and comes into contact with the resistant, glistening pericardium, more or less tensed by the condition of its contents. The margin of the pleura (characterized by its fatty areolar covering) overlies the pericardium _ and is displaced outward and away from the pericardium, by either a finger or a retractor. In this outward retraction of the pleura, the triangularis sterni muscle (often adherent to it) is also included _ as well as the internal mammary vessels, where those vessels have not been ligated. The pericardium is steadied between two forceps _ after which it may be readily punctured or incised.

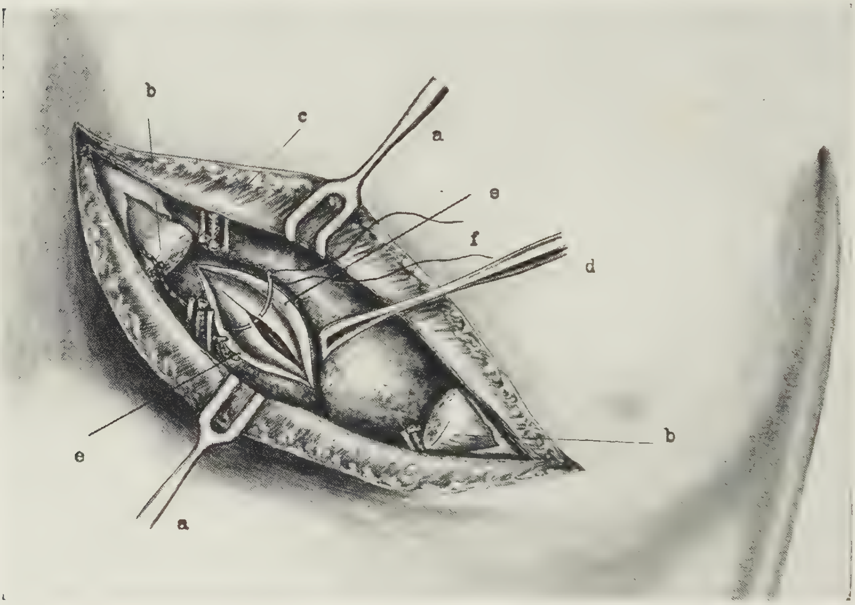

Fig. 3266.—Pericardiotomy, and Exposure of the Heart, Through the Bed of the Excised Left Sixth Costal Cartilage, With or Without the Temporary Displacement of the Cartilages Immediately Above _ By an Incision Overlying the Sixth Cartilage, or by an Angular Incision _ Kocher's Technic: _ **a, a,** Retraction of the margins of the wound through the chest wall overlying the sixth costal cartilage; _ **b, b,** sites of excision of the sixth costal cartilage; _ **c,** intercostal vessels, ligated and divided, as they lie upon the triangularis sterni (not here shown); _ **d,** retracted left lung, with its pleura unopened; _ **e, e,** retracted margins of the incised pericardium; _ **f,** suturing a wound of the heart muscle.

Where sufficient room is not secured through the excision of the left sixth cartilage alone, the fifth, fourth, and third may be additionally divided at their sternal attachments _ after which they are gradually elevated, while the pleura is carefully detached from their under surfaces (to avoid tearing the former) _ and the cartilages and attached muscles are carefully broken back (hinged) at their costal attachments _ the flap thus formed hinging outward and upward.

The pericardium is divided in the axis of the bed of the sixth cartilage, where but one has been removed _ or in the bed of the fifth, where several _ the incision running from within, outward, and slightly downward _ as shown in the illustration. Such an incision amply suffices for drainage. If the heart is to be extensively examined, the incision through the pericardium is best made in the axis of the fifth chondral bed, and along the left border of the sternum (the two being continuous). The heart can be both inspected and palpated through such an incision.

If still more room be required, the left border of the sternum may be bitten away with rongeur forceps. Even still more room may be secured, according to Durand, by first carefully separating the pleura from the posterior aspect of the sternum _ and then transversely dividing the sternum above and below, opposite the site of the exposure through the left cartilages _ and then dislocating the right costal cartilages _ hinging the flap over to the right.

In establishing drainage, the margins of the pericardial incision are sutured into the lower plane of the wound _ a rubber tube introduced, but so anchored into the wound that its inner end will not project far enough into the pericardium to wound the heart _ and the rest of the wound closed up to the exit of the drain _ using deep and superficial sutures.

PERICARDIOTOMY, THROUGH THE RESECTION OF THE SEVENTH OR SIXTH AND SEVENTH COSTAL CARTILAGES

REHN'S OPERATION

Description.—The intervening structures removed are indicated in the title. The site of exposure for drainage is especially favorable. This operation is by the epigastric route _ (that is, enters from below the costal arch) _ and is extraperitoneal and extrapleural.

Preparation; _ Position; _ Landmarks; _ Analgesia.—As in the operations for pericardiotomy already given.

Incision.—A bow-shaped incision, about 6 cm. ($2\frac{1}{4}$ inches) in length is made _ passing along the lower border of the left seventh cartilage, to the base of the ensiform process _ whence it runs transversely toward the right border of the sternum.

Operation.—Deepen this incision and carefully expose the seventh cartilage _ not subperichondrially, as in some of the methods, but extraperichondrially _ dissecting the soft parts from the cartilage, closely hugging the latter in the process. Divide the cartilage close to its junction with the sternum (it is the last cartilage which is attached to the sternum) by means of bone-shears _ (Fig. 3267). Also divide the cartilage as far from the margin of the sternum, toward its costal attachment, as necessary _ and separate the piece of cartilage from the sixth above and eighth, below, if attached (as it usually is) to these adjacent cartilages. Retract the internal mammary vessels, if necessary _ without dividing them. Having detached the soft parts, the Surgeon passes his finger beneath the sternum, bluntly dissecting its way between the lower part of the triangularis sterni and the sternal aspect of the diaphragm _ helpfully guided, in his progress, by the inferior sterno-pericardial ligament. The left margin of the sternum, corresponding with the attachment of the seventh cartilage, is excised _ and as much more of the seventh cartilage, toward the costal end, as may be necessary. The sixth costal cartilage is next excised, in the same manner if required.

In the more or less fatty connective tissue, in the bed of the wound thus formed, the pericardium is found _ the border of the left pleura being retracted outward, if encountered _ and the internal mammary vessels displaced as indicated. The progress of the operation at this step is made easier, the more the pericardium is distended _ forcing itself, as it were, into the field.

In working one's way under the sternum, one must always proceed from above downward _ so as to avoid injuring the peritoneum, which is possible in working from below upward.

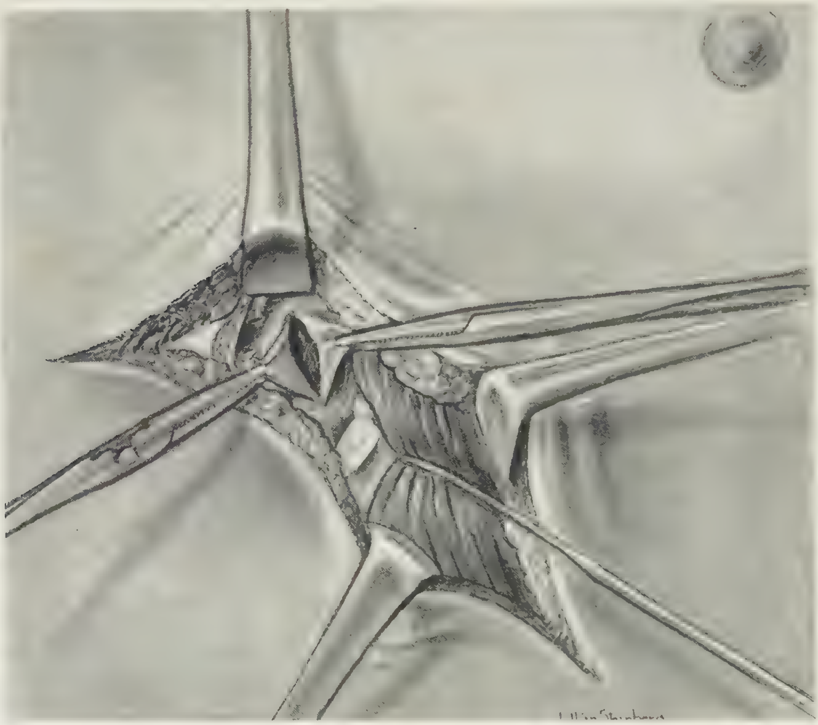

Fig. 3267.—Pericardiotomy Through the Resection of the Sixth _ (or Sixth and Seventh) Costal Cartilages _ Rehn's Operation; _ The incision (described in the text) has been made and retracted, exposing the following parts in the wound: _ The junction of the rectus and fibers of the pectoralis major are drawn outward _ the sixth costal cartilage has been excised _ the internal mammary vessels tied and divided _ the triangularis sterni fibers displaced by blunt dissection _ the pericardium incised _ and between the retracted lips of the pericardial incision the heart is seen.

Drainage, if indicated, is established by suturing the pericardium into the margin of the lower plane of the wound _ and then anchoring a rubber tube into the wound so as not to project far enough within the pericardium to damage the heart _ after which, the rest of the wound is closed up to the exit of the drain, by deep and superficial sutures.

PERICARDIOTOMY BY THE TRANSSTERNAL ROUTE THROUGH A TREPHINE OPENING

Description.—It is worthy of record that this, one of the oldest methods of exposing the pericardium, whether for puncture or incision, has, of late, come back into vogue. Matas, in writing upon the various methods of pericardiotomy, states, _ "After considering these various methods consistently with the reasons which led me to select the immediate left lower sternal and parasternal region as the safest and best for paracentesis, I must again express my preference for this route (referring to the transsternal) for pericardiotomy, just as we must aim in puncturing the pericardium to select that spot which will avoid the blood-vessels and the pleura and yet strike the pericardial accumulation where it is largest and most dependent, and where, in addition, the lower sternophrenic reflection of the pericardium will insure the greatest protection to the heart." In addition to the above personal statement the following observations are made by Matas: _

"A number of theoretic objections have been made to the sternal route by those who fear that it endangers the pleura, and that it gives insufficient space, or who look upon it as a complicated operation, while the Surgeons who have adopted the sternal route appear to be perfectly satisfied with it. Durand, Voinitch, and J. B. Roberts all agree that it is the safest and easiest route, from the anatomic point of view, and it is only because of apparent lack of space that they seem to have adopted other parasternal procedures. It is interesting to note that this, the oldest of methods, has been resurrected and made the most available at the present time, by the improvement of modern technic."

Bacon, investigating the subject as a Pathologist, reports that, out of 110 autopsies, only in 1 case would it have been impossible to enter the pericardium by the transsternal route _ and this was in a pigeon-breasted child of eight.

Doyen states, _ "The only procedure which permits approaching the pericardium without any risk of wounding either the pleura, or the mammary vessels, is the transsternal route."

It is of practical importance to remember, that if a trephine opening be made through the sternum, it can subsequently be enlarged in any direction both safely and readily, by means of rongeur forceps _ (as shown in the operation of cardiolysis, p. 43).

Technic.—The operation is probably the simplest of any for the exposure of the pericardium. It is usually performed under analgesia _ but in the emotional, anesthesia may be used. A vertical incision is made down the axial center of the sternum, with its middle corresponding with the right and left fifth sternoclavicular articulations, and midway between them. The surface of the sternum is subperiosteally exposed, with periosteal elevator _ the margins of the wound being retracted to the sternal borders. A conical trephine, of the Galt type, is employed (Fig. 3268) _ which cannot possibly slip suddenly through the opening _ and whose diameter is calculated to furnish the maximum bony opening in the particular sternum of the individual case _ is carefully carried through the breast bone _ until its penetration, by circular osteotomy, as this is, is recognized by the lost resistance and by the binding of the instrument. Doyen recommends an instrument of from 16 to 20 mm. (10/16–13/16 inches) in diameter. Upon removing the button of bone, by means of blunt dissection the endothoracic fascia and fibers of the triangularis sterni are freed from the field (and the pleura pushed back, in the rare cases where present) _ and the pericardium located with the tip of the finger. The pericardial sac is then seized with two clamp forceps and brought carefully up into the field, on a level with the wound _ and, while held in this position, is incised (Fig. 3269). Should the wound made by the removal of the button-of-bone be insufficient (which is not usually the case for simple drainage), additional room may be gotten with rongeur forceps.

In ending the operation Voinitch, Porter, and von Eiselberg suggest, as stated by Matas, that the borders of the pericardium be sutured to the margins of the sternal skin _ and that by so doing, there is less danger of septic mediastinitis, than is present in having the surface of cut bone and neighboring structures bathed by purulent discharge

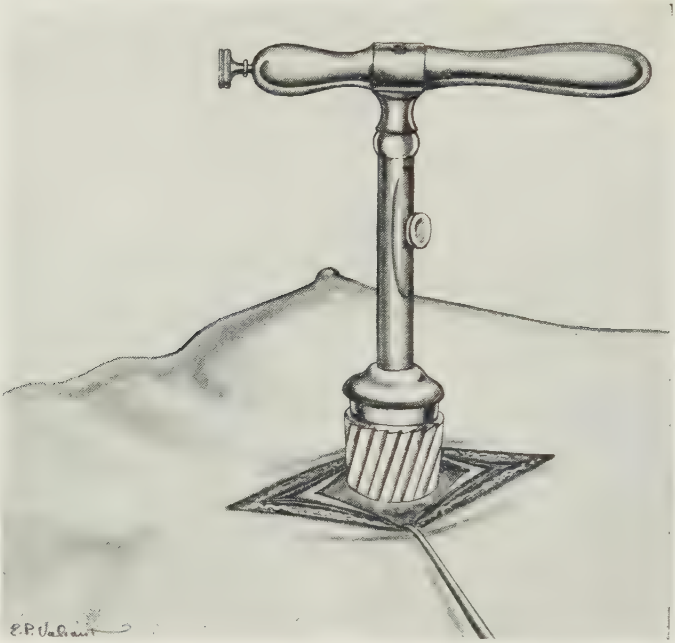

Fig. 3268.—Pericardiotomy by the Transsternal Route _ Through a Trephine opening _ I; _ A Galt trephine is in the process of sectioning the median aspect of the sternum opposite the junction of the fifth costal cartilages with the breast bone.

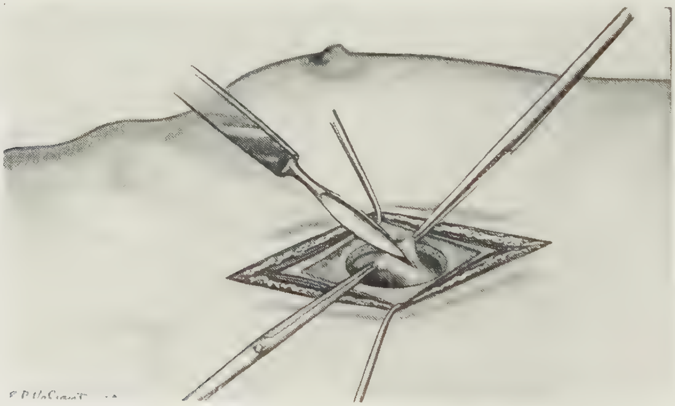

Fig. 3269.—The Same _ II; _ The pericardium, grasped by two hemostats, is delivered at the surface of the wound _ and is being incised.

PERICARDIORRHAPHY

The technic of suturing the pericardium is illustrated in Wounds of Pericardium and Heart (p. 35). There is no distinct feature about the procedure.

The surfaces, rather than the margins, are sutured together, usually by a continuous stitch – and, being serous, readily unite.

The technic will be again referred to under Wounds of the Pericardium and Heart in the section upon the Heart.

OPERATIVE TREATMENT OF WOUNDS OF THE HEART

Will be considered under Operative Treatment of Wounds of the Pericardium and Heart in the following section (p. 35).

PERICARDIA-LYSIS FOR PERICARDIO-SYMPHYSIS DUE TO ADHESIVE PERICARDITIS THROUGH A TRANSSTERNAL OPENING

Descrpition.—The surgical expression, "pericardio-lysis," or freeing of the pericardium, for pericardio-symphysis, or adhesion of the pericardium, is sometimes used indifferently for cardio-lysis, or freeing of the heart, for cardio-symphysis, or adhesion of the heart.

Further, the pathologic conditions, pericardio-symphysis and cardio-symphysis, have sometimes also been used loosely and indifferently.

In the present work, pericardio-symphysis will be considered to cover only those cases in which the visceral and parietal layers of the pericardium have formed some degree of union (often a minor degree) with each other, as a result of plastic or adhesive pericarditis – the adhesions involving no extrapericardial structures, and the operation for the separation of these adhesions, will be described as Pericardio-lysis.

Cardio-symphysis, on the other hand, will be understood to cover those cases in which not only the visceral and parietal layers of the pericardium have formed some degree of union with each other (often a maximum degree), but also with the adjacent extrapericardial mediastinal structures, as a result of an intensive form of not only combined pericarditis interna and pericarditis externa, but also an associated hyperplastic mediastinitis – eventuating in a fused and permanently adherent mass of the serous and fibrous aspects of the pericardium, on the one hand, and pleura neighboring mediastinal structures and tissues, on the other – even sometimes involving all the mediastina, and frequently very much increasing the heart's labor, and crippling its action. And the operation for the relief of this condition – that is, the major involvement of the heart as a whole (the heart, its covering, and its surroundings) – will be described as Cardio-lysis.

The use of the expression, "relief of this condition" (in speaking of cadrio-symphysis) will be noted – and not, "separation of those adhesions" (as in referring, in the paragraph above, to pericardio-symphysis). This is because actual separation of adhesions, as the compound part of the word, -lysis, signifies, is attempted in pericardio-lysis – whereas, no actual separation of adhesions is even sought in the condition of cardio-lysis, when such an operation is undertaken as, for instance, Brauer's procedure (p. 43) for relieving the labored action of the heart involved in cardio-symphysis – and which though called, "Brauer's Cardiolysis" does not pretend, or attempt, to accomplish relief by any act of freeing adhesions – but by simply mobilizing the overlying thoracic wall structures *en masse*, to which the combined pericardial and mediastinal adhesions are anchored – that is, relieving the strain upon these adhesions by allowing the neighboring chest wall to sink in toward the heart.

As a matter of fact, the operation which is chiefly performed, deliberately is so-called cardio-lysis – as cardio-symphysis (as above understood) is a much graver condition, involving graver consequences. In this same sense, minor grades of pericardio-symphysis, where only occasional bands, or scattered band-adhesions exist, is probably, in many instances, discovered only by accident, in opening the pericardium for exploration, or other purpose.

It stands to reason that a marked degree of total obliteration of the pericardial sac by adhesions is inoperable, in so far as any attempt to separate the two layers of the pericardium is concerned – for, in the first place, it is probably not accomplishable, mechanically and vitally – and, if accomplishable, would be useless, as the raw surfaces left by separation would only invite immediate reunion of even a denser grade.

Delorme suggested incising the pericardium, in intrapericardial adhesions, and separating the adhesions either digitally, or with blunt-pointed scissors. This may be undertaken by almost any of the methods of approach by which pericardiotomy has been described. It will be here described by the transsternal route.

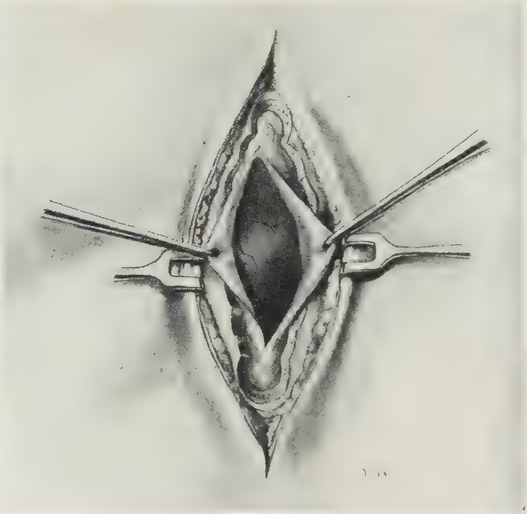

Fig. 3270.—Pericardio-lysis for Pericardio-symphysis Due to Adhesive Pericarditis – Through a Transsternal Opening; – The median aspect of the sternum, between the two trephine openings, has been bitten out with rongeur forceps. The intrathoracic cellular tissue, in the interval between the two pleural margins, and between the pleuræ and pericardium, has been freed by blunt dissection.

The pericardium has here been incised and its margins drawn through the sternal opening – and a corresponding process of cardiolysis may be carried on in those cases in which the heart and pericardium are bound together by adhesions.

Cardiolysis will be described under Operations Upon the Heart, p. 43.

Preparation; – Position; – Landmarks; – Analgesia.—As in the operation of pericardiotomy by the transsternal route, through a trephine opening, p. 14. Anesthesia may be employed, rather than analgesia.

Incision.—A vertical midsternal incision is made, 7 to8 cm. (2 $\frac{3}{4}$–1$\frac{1}{8}$ inches) in length – extending from the fourth costal cartilages, down to the ensiform cartilage.

Operation.—The technic carried out by Doyen will be here given. The above incision is deepened through the periosteum, to the bone – after which, all the overlying soft parts, including the periosteum, are separated from the bone and retracted to the two sides. The sternum is now trephined above and below, with a conical type of trephine, of 20 mm. ($\frac{3}{8}$ inch) diameter – the upper opening being on a level with the cartilages of the fourth ribs _ the lower, just above the sternoxiphoid articulation. Having carefully fully completed these two circular osteotomies and removed the buttons of bone, the intervening bone between them is bitten out with rongeur forceps _ or cut out by an electrically-driven saw, traveling over a guard. (If a wedge-shaped section of bone be thus removed, it may be replaced as a bone-graft at the end of the operation _ the bevel preventing its slipping into the thorax.)

At the bottom of the bony opening thus made, one seeks, by blunt dissection with the finger-tip and blunt dissector, to open up the cellular interval between the two anterior borders of the pleuræ, and between the pericardium and the pleuræ _ displacing them to either side. The pericardium is then recognized _ seized and steadied by two forceps _ and incised in the median line between them, for a length sufficient to afford manipulation. The edges of the pericardial wound are then carefully clamped and delivered outside of the wound (Fig. 3270). The Surgeon now carefully introduces first his right, and then his left index-finger between the retracted pericardium and the heart, on the right and left sides of the heart _ progressing with extreme care, in his attempt to sweep the finger backward, on each side, toward the posterior aspect of the organ _ separating the adhesions as he advances _ and using, where the way seems safe, and the indication plain, blunt, curved scissors (with their concavity toward the heart) for dividing resisting bands. It is useless to attempt to proceed, if the parts are everywhere welded together, so that large raw surfaces will be left to reunite (such cases for which the Brauer thoracoplastic procedure is better).

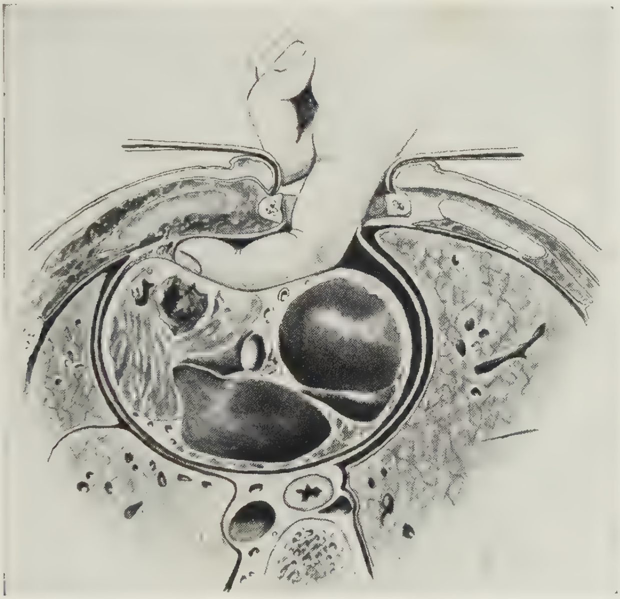

Fig. 3271.—The Same _ III; _ The insertion of the index-finger into the pericardial cavity, in the act of separating the pericardial adhesions between heart and pericardium. The adhesions of the opposite side have been separated.

At the conclusion of the operation, the margins of the pericardium are sutured together with catgut _ and dropped back into position. If a beveled piece of sternum have been sawn out between the two openings made by trephine, or by fraise, this is replaced. In either event, the periosteum is turned back into place, with the rest of the attached soft parts. It is well to make provision for temporary drainage of the wound fluids (and possible pericardial leakage), by a drain led out from the pericardial surface, through one of the lower bone openings and an unsutured part of the soft wound.

Comment.—It is readily understood that freer access may be obtained through the approach accomplished by the resection of one or more cartilages of the left side _ especially a freer access to the left side of the heart. But, anatomically, approach through the center of the sternum must bring both sides of the heart into easier reach, simultaneously _ unless special measures be taken to draw the heart within reach after exposure upon the left side. A thoracoplastic flap exposure gives, of course, the maximum exposure to the whole heart.

EXPERIMENTAL PERICARDIECTOMY

Mazzone demonstrated, in 1912, that animals deprived of their pericardium, in whole or in part could live. Parlavecchio also corroborated the fact _ but showed that left ventricular hypertrophy and general emaciation invariably followed. It was shown that total pericardiectomy was better tolerated than partial pericardiectomy. The left pleural cavity partly played the rôle of the pericardial cavity.

There are known instances of life with congenital deficiencies of the pericardium.

The work was done in connection with the possibility of having to remove large parts, or all, of the pericardium in cases of malignant involvement _ and also in persistent chronic suppurative pericarditis.

The suggestion has been made by Henschen, as mentioned by Pool, that defects of the pericardium be grafted from the fascia lata.

CHAPTER LVII

OPERATIONS UPON THE HEART

Surgical Anatomy, p. 21; – Surface form and landmarks, p. 23.

Operations for Exposing the Pericardium and Heart, in General, p. 23; – Exposure of the pericardium and heart by a chondroplastic flap (Kocher), p. 24; – Exposure of the pericardium and heart by thoracoplastic flaps of the soft parts, and then of the third, fourth, and fifth costal cartilages, raised separately (Burghard), p. 27; – Exposure of the pericardium and heart by a thoracoplastic flap hinging inward (Rotter), p. 32; – Exposure of the pericardium and heart by major intercostal thoracotomy (Wilms), p. 33.

Operative Treatment of Wounds of the Pericardium and Heart, p. 35; – Pericardiotomy, p. 35; – Pericardiorrhaphy, p. 36; – Cardiorrhaphy, p. 36.

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Cardio-lysis (or Thoraco-lysis Præcardiaca) for Cardio-symphysis Due to Chronic Adhesive Mediastino-pericarditis (Brauer), p. 43.

Experimental Operative Surgery of the Heart, p. 45.

SURGICAL ANATOMY OF THE HEART

Position of the Heart and Its Various Parts.—Occupies the greater portion of the middle mediastinum – lying obliquely behind the lower two-thirds of the sternum – and projecting about 7.5 cm. (about 3 inches) to the left of the median line, and about 4 cm. (about $1\frac{1}{2}$ inches) to the right of the median line – extending from above to the right, to below and to the left. **Base**; directed upward, backward, and to the right, corresponding to the interval between the fifth and ninth dorsal vertebræ. **Apex**; directed downward, forward, and to the left corresponding to the chest wall between the fifth and sixth costal cartilages – at a point about 2 cm. (about $\frac{3}{4}$ inch) to the inner side, and about 4 cm. (about $1\frac{1}{2}$ inches) below the left male nipple. **Inferior border**; corresponds to the right ventricle and rests on the central tendon of the diaphragm. **Anterior border**; corresponds to the right auricle. **Left border**; corresponds to the left ventricle. **Anterior surface**; formed mainly by the right ventricle and part of the left. **Posterior surface**; formed mainly by the left ventricle.

Relations of Heart to Chest Wall.—**Base**; corresponds to line from a point on the lower border of the second left costal cartilage 2.5 cm. (1 inch) from the sternum to the upper border of the third right costal cartilage 1.2 cm. (about $\frac{1}{2}$ inch) from the sternum. **Apex**; corresponds to a point 3.8 cm. (about $1\frac{1}{2}$ inches) below, and 2 cm. ($\frac{3}{4}$ inch) internal to the left male nipple – which is about 9 cm. (about $3\frac{1}{2}$ inches) to the left of the median line, and between the fifth and sixth costal cartilages, and just internal to the end of the fifth rib. **Lower border**; corresponds to a line from the apex, with slight downward convexity, to the seventh right chondrosternal articulation. **Right border**; represented by a line joining the right extremity of the base line with the right extremity of the lower borderline (seventh right chondrosternal articulation), with a slight outward convexity projecting about 3.8 cm. (about $1\frac{1}{2}$ inches) from the median line. **Left border**; represented by a line joining the left extremity of the base-line with the apex-point, with slight convexity to the left – extending about 7.6 cm. (about 3 inches) to the left of the median line of the sternum.

Relations of Parts of Heart to Chest Wall.—**Right auricle**; behind the sternal ends of the third, fourth, fifth, and sixth costal cartilages of the right side; the corresponding intervening spaces; and the right border of the sternum. **Right auricular appendix**; behind or to the left of the median line, on level with the third costal cartilages. **Left auricle**; extends vertically from the level of the lower border of the second left costal cartilage to the upper border of the fourth — and corresponds, horizontally, with the body of the seventh dorsal vertebra and heads of the adjoining left ribs. **Apex of left auricular appendix**; behind the third costal cartilage, about 3.2 cm. ($1\frac{1}{4}$ inches) to the left of the sternum. **Right ventricle**; extends from the third costal cartilage above, to the seventh costal cartilage below, on the left side. **Right auriculo-ventricular sulcus**; represented by a line obliquely upward, from the sternal end of the sixth right costal cartilage, to the third left costal cartilage. **Left ventricle**; not in contact with the chest wall, except a small part of the apex of the left ventricle during expiration.

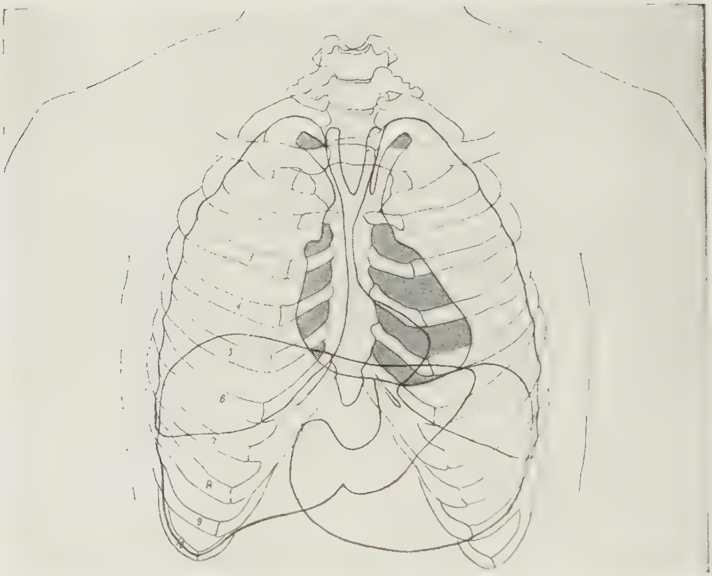


Fig. 3272.—Surface View of the Heart and Pericardium, Shown in Relation with the Overlying Osseo-cartilaginous Chest Wall; — The pleura-free surface of the heart is shown within the inner borders of the pleuræ, opposite the fourth, fifth, and sixth rib cartilages. The upper limit of the diaphragm and the contours of the stomach and liver are seen.

Relations of Orifices of Heart to Chest Wall.—**Pulmonary orifice** (Pulmonary Semilunar Valves); behind the junction of the upper border of the left third costal cartilage with the sternum. **Aortic orifice** (Aortic Semilunar Valves); behind the left half of the sternum, opposite the lower border of the third costal cartilage. **Left auriculo-ventricular opening** (Mitral Valves); behind the sternum, to the left of the median line, opposite the fourth costal cartilage. **Right auriculo-ventricular opening** (Tricuspid Valves); behind the center of the sternum, opposite the fourth intercostal space.

Relations of Uncovered Area of Heart to Chest Wall.—The triangular area of the heart uncovered by pleura is represented within the three following lines: — (*a*) Draw a line downward and to the left from the middle of the sternum, between the fourth costal cartilages, to the apex of the heart; (*b*) Draw a line from the starting-point of the first line down the lower third of the central line of the sternum; _ (*c*) Draw a line from the sternal end of the sixth right costal cartilage through the seventh left costal cartilage.

Arteries.—Anterior and posterior coronary.

Veins.—Correspond with arteries, emptying into right auricle.

Lymphatics.—End in thoracic and right lymphatic ducts.

Nerves.—From cardiac plexus.

SURFACE FORM AND LANDMARKS OF THE HEART

The surface relationships of the heart have been given under the Surgical Anatomy of that structure.

Topographically, from the surgical standpoint, the minor differences in the relations of the heart and adjacent structures, as given by Anatomists, are not of practical importance.

The classic landmarks given by Holden (quoting from Matas) are the following: _ "(*a*) To define the **base,** draw a transverse line across the sternum, corresponding with the upper border of the third costal cartilage; continue the line ½ inch to the right of the sternum, and 1 inch to the left. (*b*) To find the **apex,** mark a point about 2 inches below the left nipple (male), and 1 inch to its sternal side. This point will usually be found between the fifth and sixth ribs, 3½ inches from the middle line of the sternum. (*c*) The **lower border,** which lies on the central tendon of the diaphragm, is indicated by a line slightly curved downward, from the apex across the bottom of the sternum (sterno-xiphoid junction) as far as its right edge. (*d*) The **right border** (formed by the right auricle) is outlined by continuing the last point upward from the right sternoxiphoid junction with an outward curve, so as to join the right end of the base. (*e*) To define the **left border** (formed by the left ventricle), draw a line curving to the left, not including the nipple from the left end of the base-line to the apex. The greater part of the heart lies within the left half of the chest; the only part which lies on the right of the sternum is the right auricle."

OPERATIONS FOR EXPOSING THE PERICARDIUM AND HEART, IN GENERAL

As Kocher has written, the ever restless and defiant heart has at last come under surgical treatment.

It was only in 1882 that Billroth considered the contemplation of pericardial puncture a surgical frivolity _ and the prostitution of surgical art.

Many lives have been saved by surgical interference, in wounds of the heart _ 80 out of 190 (or nearly one-half), in one collection of cases, where death seemed otherwise certain _ who, formerly, would have been given the small chance of recovery without operation.

Up to the present time the chief surgery which has been performed upon the heart, has been in connection with wounds of the heart and pericardium _ the removal of foreign objects which have caused wounds _ and the repair of wounds.

The operative technic, therefore, has mainly consisted of devising methods of exposing the heart _ of removing wounding bodies, if still present _ and of suturing such wounds.

In view of what has happened in the past, in this and other fields, it would be surgical arrogance to suppose that the limit of human attainment had been here reached _ or that other so-considered purely medical aspects of cardiac pathology might not be surgically invaded with success.

The methods of exposing the heart are many. Those which are most frequently employed may be grouped under four headings: _ (*a*) Interchondral and intercostal precordial incisions, with retraction of the cartilaginous, or bony boundaries, but without section of these; _ (*b*) Incision of the soft chest wall, with permanent excision of the necessary precordial cartilages and ribs; _ (*c*) Thoracoplastic flap methods, with temporary resection of cartilages alone _ or of cartilages and ribs _ or of some part of these, with some part of the sternum _ or of some part of the sternum.

The most frequently adopted procedures fall within the last category _ some form of thoracoplastic flap exposure _ several of the most frequently used being here given.

EXPOSURE OF THE HEART AND PERICARDIUM BY A CHONDRO-THORACOPLASTIC FLAP

KOCHER'S METHOD

Description.—The operation was devised for exposing the heart in the case of wounds, and the flap, therefore, is planned with some reference to the individual wound, when that is possible, or the situation would be helped thereby. As a rule, the flap includes the left third, fourth, fifth, and sixth cartilages, and is hinged outward, at their junction with the ribs _ and consists of soft parts and cartilages.

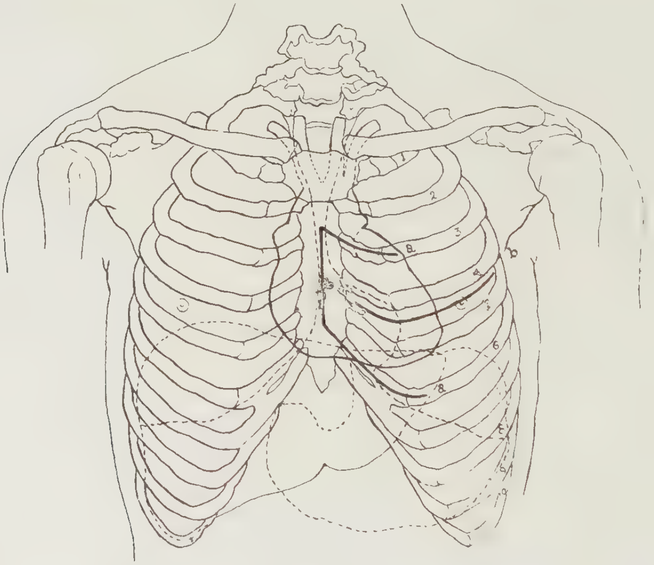


Fig. 3273.—Incisions for Exposing the Heart: _ **a, a,** Kocher's incision, down the middle of the sternum, from opposite the center of the third, to opposite the center of the sixth costal cartilage, and outward over these cartilages, to just beyond the chondrocostal junction; _ **b, b,** exposure by the major intercostal incision, in the left fourth intercostal space, from the sternum, outward to the angles of the ribs, if necessary

Preparation.—All should be in readiness for the employment of differential respiratory pressure _ in the event that the pleura be wounded during the operation.

Position.—The patient is supine, with the thorax rendered prominent by support, and the intercostal spaces separated.

Landmarks.—Left border of the sternum _ and the left third, fourth, fifth, and sixth costal cartilages.

Incision.—The vertical incision is made down the center of the sternum, from opposite the middle of the chondrosternal articulation of the third cartilage, to opposite the middle of the chondrosternal articulation of the sixth cartilage (Fig. 3273). The upper transverse incision begins at the upper limit of the vertical incision, and extends along the middle of the third cartilage, to just beyond its junction with the rib. The lower oblique incision begins at the lower border of the vertical incision, and extends along the middle of the sixth cartilage, to just beyond its junction with the rib. If indicated, the vertical incision may extend higher _ and the upper transverse incision be over the second cartilage.

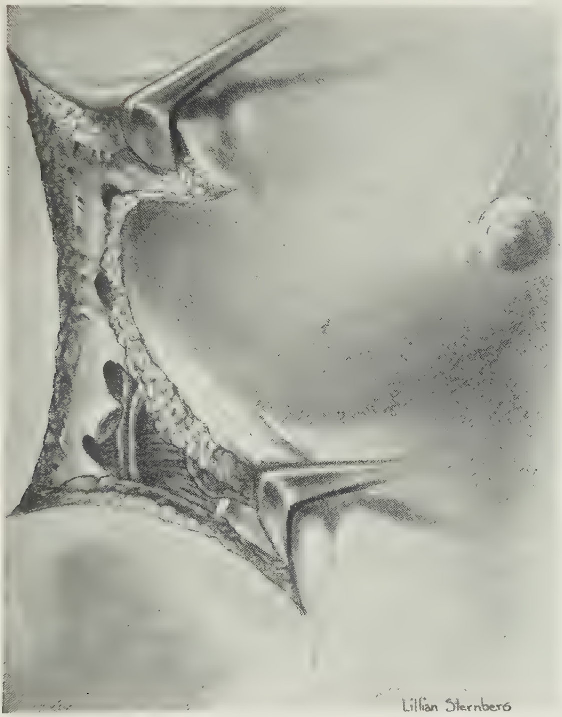


Fig. 3274.—Exposure of the Heart by a Chondroplastic Flap _ Kocher's Operation _ I; The incision passes over the left aspect of the sternum, from the third to the fourth ribs, and outward over these, to just beyond their cartilages. The structures in the lines of the incision have been exposed _ the cartilage of the sixth rib excised _ and the internal mammary vesels, lying upon the triangularis sterni, are about to be displaced or doubly ligated and divided.

Operation.—The vertical incision passes down to the sternal periosteum. The upper transverse incision is carried through the pectoralis major, down to the third cartilage and rib _ and the tendinous and muscular fibers of the intercostal muscles are detached from the upper border of this rib (Fig. 3274). The lower oblique incision, about 10 cm. (4 inches) in length, passes down to the sixth cartilage and rib, through the costal attachment of the rectus abdominis _ and the fibers of the pectoralis major and rectus abdominis, as well as the intercostal muscles, are detached from both the upper and lower borders of the cartilage and rib. An incision is made through the anterior aspect of the perichondrium of the sixth rib, after which it is freed subperichondrially _ and divided at its attachment with the sternum. Drawing the sternal end of the cartilage forward, its connection with the seventh cartilage is divided. The sixth cartilage is then divided at its costal end. The posterior aspect of the perichondrium of the sixth rib is left in the wound, lying, as it does, upon the triangularis sterni, the internal mammary vessels intervening. The internal mammary artery and veins, passing near the sternal border, are divided between two ligatures. The triangularis sterni, behind the mammary vessels, is divided close to the sternum _ and is displaced outward. It is adherent to the pleura, which is usually readily recognized by a fatty areolar layer. The pleura is readily separated from the pericardium, which is recognized by its tough, glistening structure _ and, if emergency demands, the pericardium can be easily incised at this stage. Displacing the triangularis sterni and the pleura, and continuing the line of incision along the sternum, the fifth costal cartilage is divided close to the sternal border _ and the fourth also _ and, if necessary, the third, as well.

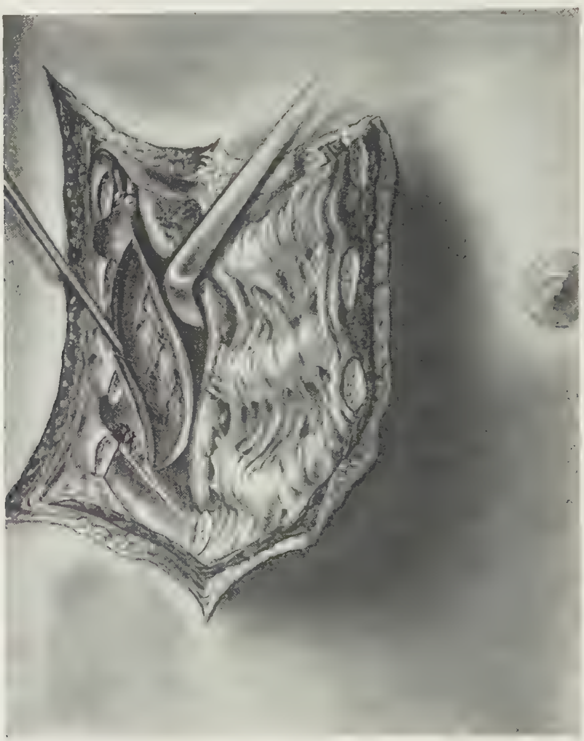


Fig. 3275.—The Same _ II; _ The chondro-thoracoplastic flap has been broken back, showing the bed of the excised sixth costal cartilage, and the sternal ends of the divided third, fourth, and fifth costal cartilages. The internal mammary vessels have been tied above and below, and divided. The anterior margin of the left lung is being displaced upward and outward. One of the margins of the incised pericardium is being retracted _ and the surface of the heart, with ramifying coronary vessels, is seen in the depth of the wound

Three sides of the square are thus freed . after which the flap is carefully bent outward, toward the axilla, while the triangularis sterni and the pleura are further held out of the way _ and is broken across through the cartilages at their junction with the ribs, and hinged backward (Fig. 3275). During the act of backward breaking, one protects the pleura as well as possible with the fingers of the opposite hand – for it is then that damage to the pleura is most apt to occur by the broken ends of the cartilages or ribs – and if this be done, the damage is at once repaired by suturing. Sometimes the ribs are broken back, more posteriorly, as the operation progresses, thus forming a second breakage and backward hinging of the thoracic wall. When this thoracoplastic flap has been turned back, the heart is found exposed from its auricles to its apex – and whatever special procedure is indicated, is carried out.

If the great vessels must also be exposed, it is necessary to divide the second costal cartilage also, and include it in the flap.

If still more access be required, especially of the right heart, particularly the auricle, one separates the soft parts from the posterior aspect of the right side of the sternum – then divides the sternum transversely across at the indicated levels, above and below, with Gigli saw, or bone-cutting forceps – after which the segment of the chest wall represented by the cut-out portion of sternum, and the cartilages attached thereto, are turned outward, toward the right, when the cartilages will break at their articulation with the ribs (and not at the sternum – according to Terrier and Reymond).

The heart may be displaced by passing two fingers behind it and raising it up – which is often necessary in suturing it. And to expose its posterior aspect the apex may be seized with Museaux forceps.

Comment.—It requires no argument to convince one's self of the greater surgical accuracy of first deliberately dividing bones and cartilages at the site of their hinging, rather than accomplish the hinging by crude and inaccurate breaking. This more technical method is shown in Fig. 3278. In the latter method it will not be necessary to make it a part of the operation to be on the lookout for wounds of the pleura by jagged ends of cartilages or ribs – as the flap is crudely broken back – instead of being carefully hinged back, after accurate division of the site of hinging.

EXPOSURE OF THE HEART AND PERICARDIUM BY THORACOPLASTIC FLAPS OF THE SOFT PARTS AND THEN OF THE THIRD, FOURTH, AND FIFTH COSTAL CARTILAGES, RAISED SEPARATELY

BURGHARD'S TECHNIC

Description.—The distinctive feature of the operation consists in the raising, first, of a trap-door flap of the overlying soft parts of the precordial chest wall – followed by the raising of an underlying flap of the fourth, fifth, and sixth costal cartilages and ribs, and intercostal muscles – rather than of all the structures of the thoracic wall together, as is usually done. The claim for this method is greater ease and accuracy – both as to making the exposure and repairing it.

Preparation.—The usual local preparation for a major intrathoracic operation – and the having on hand of some method of differential pressure, in the event of finding pneumothorax, or causing it during operation.

Position.—Supine, with chest prominent, and turned slightly toward the right side.

Landmarks.—Sternum and fourth, fifth, and sixth cartilages and ribs.

Anesthesia-analgesia.—Anesthesia is usually employed – unless the special condition of the case makes it too dangeous, when analgesia is used.

Incision.—The sternal incision passes down the sternum, between its center and the left margin, extending from just above the attachment of the fourth costal cartilage, to just below the attachment of the sixth. The upper incision is carried along the upper border of the fourth cartilage and rib — and the lower incision, along the lower border of the sixth cartilage and rib.

Operation.—Within this area included by the three incisions, the soft flap is first raised, consisting of skin, fascia, and muscle tissue of the thoracic wall (chiefly pectoralis major) overlying the rib-plane — and is turned outward (Fig. 3276). The bleeding vessels are clamped. The soft parts between the cartilages are divided next the sternum, and the three cartilages are then carefully divided along the left sternal border, extraperichondrially — that is, no attempt is made to separate the perichondrium. The upper and lower incisions are deepened into the plane of the endothoracic fascia — and extend outward for about 7.7 cm. (3 inches). This flap of cartilages and ribs is then bent forcibly outward, breaking the ribs along a vertical line about 7.7 cm. (3 inches) from the sternum. In this backward breaking, effort should be made to preserve the pleura from injury. If the pleura have been wounded by the original injury for which the operation itself was undertaken, or if it is wounded during the manipulations — and no means for differential pressure be at hand — pneumothorax usually follows — and the condition must be met by drawing the lung forward and suturing it into the intercostal margin. Unless the internal mammary vessels can be displaced well to the inner side, they are doubly ligated and divided — and it may be necessary to ligate one or more intercostal vessels. The triangularis sterni attachments are divided. The left pleura, with enclosed lung, is displaced outwardly to the left and upward — and the

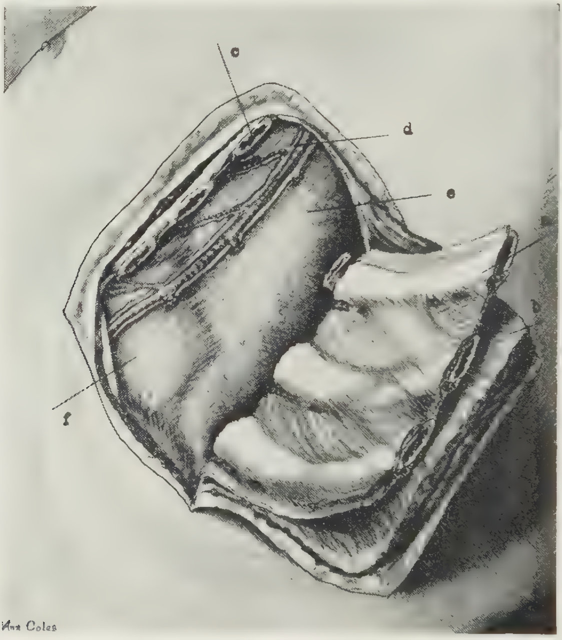


Fig. 3276.—Exposure of the Heart and Pericardium by Thorocoplastic Flaps of the Soft Parts and Then of the Third, Fourth, and Fifth Costal Cartilages, Raised Separately — Burghard's Technic — I: — **b,** The superficial flap of skin, fascia, and overlying pectoralis major and minor, turned backward; — **a,** the underlying flap of the left third, fourth, and fifth costal cartilages and ribs, broken back; — **c,** sectioned costal cartilages; — **d,** internal mammary vessels; — **e**, left lung, covered by its pleura; — **f,** pericardium, uncovered by lung — and from between which and the internal mammary vessels the triangularis sterni has been freed.

right pleura, if in evidence, toward the median line (Fig. 3277). The pericardium is then grasped between two toothed forceps and incised _ after which the margins of the pericardium are clamped, and aid in steadying the heart in subsequent manipulations.

The pericardium is often filled with blood and clots, and sometimes air and froth from wounded lung tissue _ and these must all be emptied out and wiped away _ by suction-drainage and gauze-wipes _ before a careful investigation of the nature of the injury can be made. The wound, once discovered, must be dealt with according to its special nature _ as will be covered under Wounds of the Heart and Pericardium, p. 35.

After completing the object of the operation and suturing the pericardium, the flap of ribs and intercostal muscles is turned down into place and sutured with absorbable material, carried through the intercostal structures. The outer flap of soft parts is then turned into place _ a few buried sutures carried through the muscle tissue _ and the skin united.

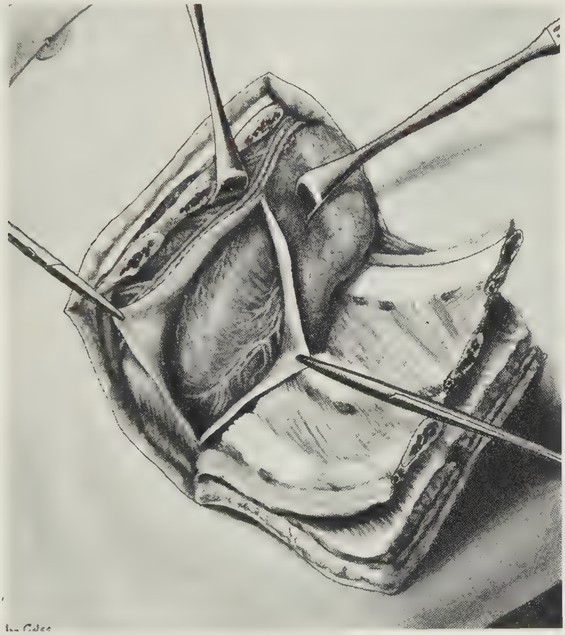


Fig. 3277.—The Same _ II; _ The margin of the left lung _ and that of the right, if in the field _ is retracted _ the pericardium incised _ and the heart exposed, upon the retraction of the margins of the incised pericardium.

Comment.—Instead of breaking-back the underlying flap of ribs and intercostal muscles, it can be more accurately hinged back, if the ribs are first subperiosteally sectioned at the site of hinging _ which is very readily accomplished after their full exposure resulting from the turning back of the superficial flap of soft parts _ as shown in Fig. 3278.

If, instead of raising the flaps in two layers, as described in the body of the article, it be determined to raise all the structures of the thoracic wall *en masse*, as is usually done, this is readily accomplishable by first subperiosteally dividing the ribs where the hinging will occur _ as pictured in Fig. 3278.

In operating upon the female, with full breasts, the presence of the left breast will naturally offer some element of difficulty in making the exposure

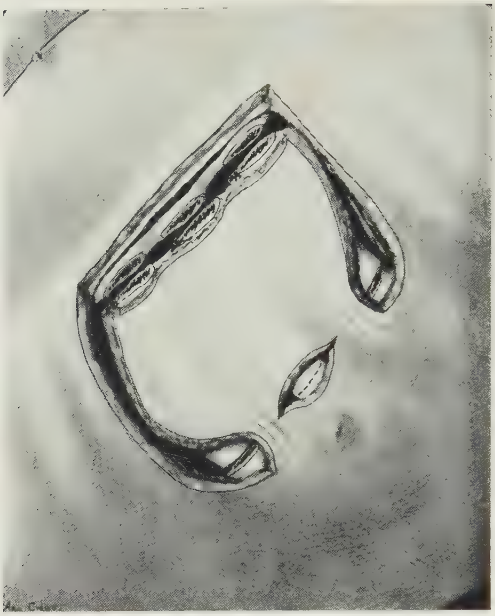


Fig. 3278.—Exposure of the Pericardium and Heart by a Thoracoplastic Flap, Raised as a Single Layer – In which the outer section of the ribs has been accurately made in advance, so that the composite flap will hinge backward evenly and safely, instead of breaking backward uncertainly and dangerously.

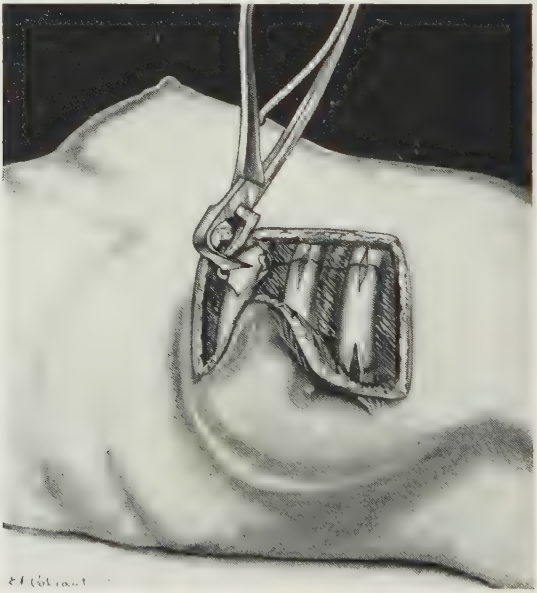


Fig. 3279.—The Exposure of the Pericardium and Heart, in the Female, by Thoracoplastic Flap – Doyen's Technic – I; – The sternal ends of the third, fourth, and fifth cartilages are divided with right-angled bone-cutting forceps.

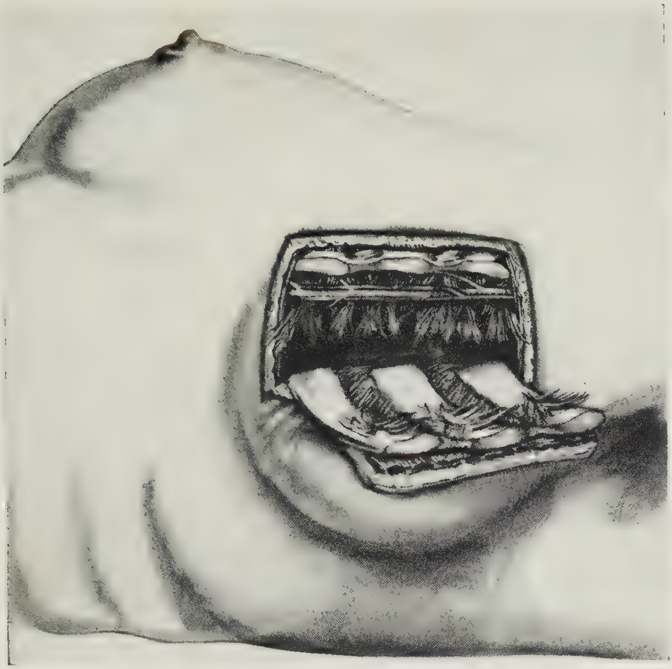


Fig. 3280.—The Same – II; – The composite flap, turned outward – exposing the internal mammary vessels – and exposing the pericardium, after separating the fibers of the triangularis sterni.

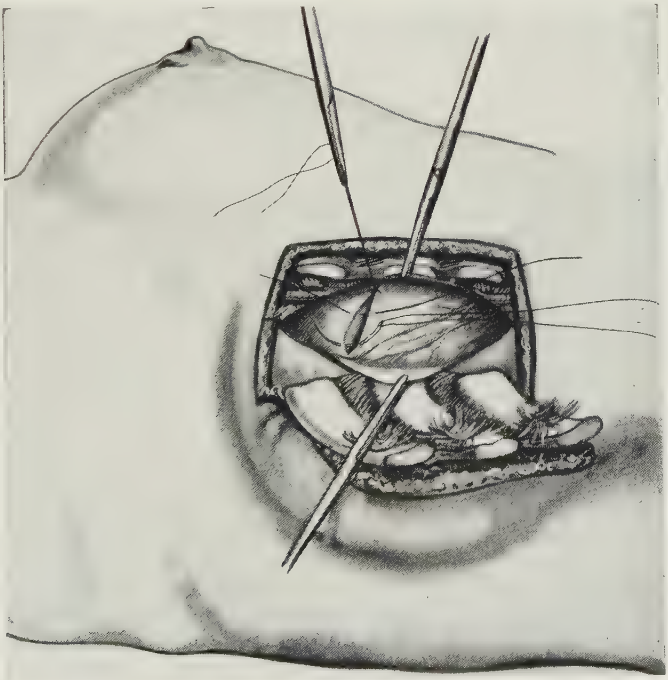


Fig. 3281.—The Same – III; – The flap and inner aspect of overlying left breast is hinged outward – the pericardium incised – its margins held apart – and a wound of the left ventricle being sutured, while steadied by the first suture used as a traction suture.

of the pericardium and heart. This difficulty may be minimized by adopting the technic suggested by Doyen. Having outlined the trap-door flap, the sternal ends of the ribs are sectioned by means of special bone-cutting pliers (Fig. 3279). The soft parts, including upper and lower aspects of the base of the breast, are then displaced toward each other, exposing the uppermost and lowermost ribs _ which will enable these ribs to be readily cut by the special pliers mentioned (Fig. 3280) _ after which, by a little manipulation, the middle rib (or the two inner ones, if four be included in the flap) may generally be exposed, from the region of the cut ribs, though with more difficulty, and be also similarly divided. It is then possible to deliberately hinge backward (rather than roughly and inaccurately break backward) the thoracic flap _ and with it that portion of the breast which overlies it _ thus exposing the pericardium, which is incised, and the heart _ where, in the present illustration, a wound of the left ventricle is being sutured, while the heart is being steadied by the first suture placed, used as a traction suture (Fig. 3281).

EXPOSURE OF THE HEART, AND PERICARDIUM BY A THORACOPLASTIC FLAP, HINGING FORWARD

ROTTER'S OPERATION

Description.—The heart is exposed through a thoracoplastic flap consisting of the fourth and fifth costal cartilages and parts of the corresponding ribs. No attempt to preserve the pleura intact is made _ as that membrane is almost always involved in the injury and it is generally indicated to remove blood from its cavity.

Preparation.—As pneumothorax may have occurred prior to operation, or may take place in the course of the operation, the operation should be performed under differential pressure. In this way the collapse of the lungs and, therefore, of the heart is avoided.

Position.—Patient supine, preferably resting upon some object which will elevate the chest and render it prominent and thus increase the width of the intercostal spaces.

Landmarks.—Left border of sternum; third, fourth, and fifth ribs and their cartilages; mammary line.

Incision.—A flap is outlined with its hinge near the left border of the sternum _ beginning about 2 cm. ($\frac{3}{5}$ inch) from the left margin of the sternum. These incisions are continued along the lower borders of the third and fifth ribs _ and may extend outward in the interspaces as far as the mammary line. Their outer ends are connected by a vertical incision (Fig. 3282, A).

Operation.—In the horizontal incisions are divided the skin, fascia, pectoralis major and minor, intercostals, and generally the parietal layer of the pleura. The vertical incision does not at first go deeper than the pectoral muscles. The intercostal vessels are ligated and the fourth and fifth ribs divided _ and the incision is then carried to the pleura. The entire cutaneo-musculo-periosteo-osseous flap is now turned upward and inward. Even if the pleura have previously escaped, it may be torn in the process of exposure and turning back of the flap. Pneumothorax should be prevented, if operating without differential pressure, by drawing the lung forward and suturing it to the intercostal muscles _ or the opening in the pleura may be covered by gauze tampons, the lung being pushed backward and outward. When the flap is turned upward and inward, the triangularis sterni muscle is torn. The costal cartilages are apt to break near their articulations _ disarticulation should, however, be carried out. The internal mammary artery is generally left intact.

The fatty areolar tissue over the pericardium is retracted and the pericardium incised in its longitudinal axis, from its infero-external aspect. Fixation sutures are introduced into the muscular tissue of the apex of the heart if necessary to steady it in the indicated manipulations. All accumulated blood in the pericardium is removed. The special object of the operation is now accomplished. Unless specially indicated, the pericardium is sutured without drainage (as the constant impact of the heart against the drain is apt to produce pericarditis). Drainage may be used down to the pericardium in closing the wound.

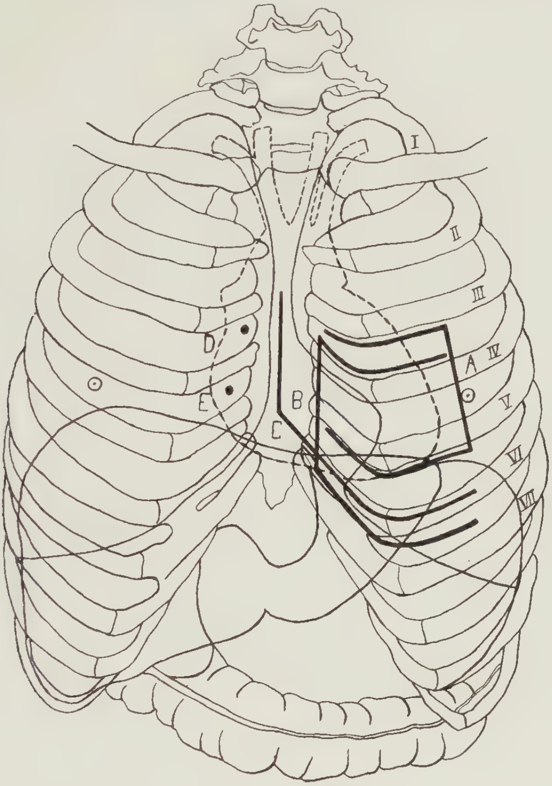


Fig. 3282.—Sites for Paracenteses and Lines for Exposures of the Heart: — D, Paracentesis of right auricle; E, paracentesis of right ventricle; A, Rotter's thoracoplastic flap; B, Fontan's thoracoplastic flap; C, Kocher's thoracoplastic flap.

EXPOSURE OF THE HEART AND PERICARDIUM BY THE MAJOR INTERCOSTAL INCISION

WILMS' TECHNIC

Description.—The general principle of the incision of exposure, and its manipulation, are the same in principle, as exemplified in the case of applying that method of approach to operations upon the pleural and pulmonary aspects of the chest, in general (Vol. III, p. 822).

In speaking of the technic in heart operations Sauerbruch states that three factors are of decisive importance — differential pressure — and the intercostal method of approach, made available _ and infection avoided. He considers that exposure of the heart by the major intercostal incision has the advantage over all other methods _ as being the simplest and most expeditious _ which are especially valuable considerations in that class of cases in which prompt exposure of the heart is most often called for _ namely, in wounds of the organ.

Preparation.—As for major thoracic operations in general.

Position.—The patient lies in the right half-lateral position _ with the chest prominent.

Landmarks.—The sternum, and fourth and fifth left cartilages and ribs _ defining the fourth intercostal space.

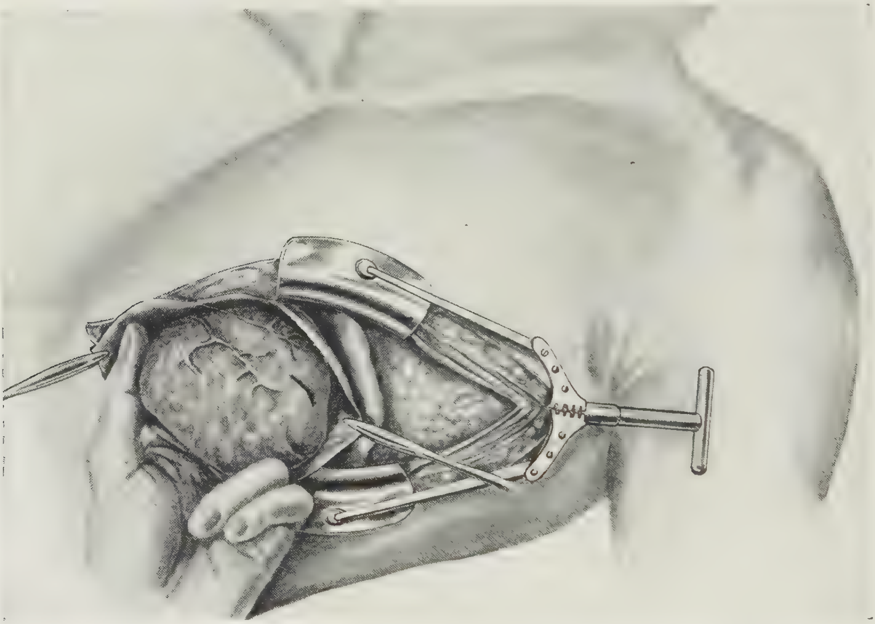


Fig. 3283.—Exposure of the Heart by the Major Intercostal Incision _ Wilms' Technic; _ The incised margins of the fourth left intercostal space are separated by rib-retractors _ the pleura-covered lung exposted and dispaced outward _ the pericardium drawn forward with two pairs of forceps, and incised between them _ followed by traction upon the lips of the pericardial wound, and forward displacement of the heart by two left fingers introduced into the pericardial sac, behind the organ _ thus exposing a wound of the left ventricle. The margin of the left lung is displaced outward.

Anesthesia-analgesia.—The former, if the patient's condition permits it.

Incision.—An incision is made through the soft tissues of the chest wall, in the left fourth interchondral and intercostal space _ extending from over the left margin of the sternum, as far outward as may be considered requisite to secure the necessary opening, through the retraction of the adjacent ribs _ even though the incision pass backward to the angles of the ribs.

Operation.—The incision is deepened through the thoracic wall, down through the endothoracic fascia _ doubly ligating and dividing the internal mammary vessels near the sternal end of the wound. The rib-separators are then placed in position, and the fourth and fifth ribs and their cartilages, carefully and slowly separated sufficiently to admit of easy approach to the pericardium and heart _ guided, in large part, by the wound, if one be present. The pericardium is encountered at the anterior border of the left lung which is displaced somewhat outward, in order to gain free access to the heart _ the pericardium moving with the heart, and the lung moving with respiration. It is to be remembered that if the pericardium be distended by blood poured out from a wounded heart, it may present itself in the wound as a large tumor. The pleura-covered lung is usually readily separated from the pericardium _ and is held out of the wound either by gauze tamponing, or by retraction _ and is kept under about 3 mm. Hg. differential pressure.

The pericardium is seized between two toothed forceps, grasping its wall in convenient sites _ and incised in the axis of the heart, for a length that will admit of free access to the heart muscle, having regard to the position of the wound, if any. The lips of the pericardial wound are then seized with clamp-forceps and held apart (Fig. 3283). In the case of wounds there may be a tendency for the blood to flow, in gushes, freely through the incised pericardium _ but continued bleeding from the heart is usually controllable by gauze tamponing _ so that an opportunity to investigate the nature of the lesion is given. Wounds of the anterior aspect of the heart, especially of the left ventricle, are quite accessible. For wounds in other regions, especially of the right ventricle and base of the heart, it is often necessary to manipulate the heart for their best exposure _ and this is usually accomplished by insertions of the operator's left index and middle fingers into the pericardial cavity, with the pulps of the fingers in contact with the base and right ventricle _ which will enable him to direct the exposure of the different parts of the organ. The control of the heart may be further accomplished by carrying a temporary traction-ligature through the musculature of the apex _ if this be considered necessary.

The technic of heart suture is discussed under Wounds of the Heart (p. 35) _ and also the drainage of heart wounds _ and closure of the pericardium.

At the end of the operation the pericardial sac is cleansed of blood, and the thoracic wound is closed as in the ordinary cases where it is applied to the chest wall at large _ the question of drainage being determined under the heading mentioned above.

OPERATIVE TREATMENT OF WOUNDS OF THE PERICARDIUM AND HEART

These had best be considered together _ for wounds of the pericardium are often associated with those of the heart _ and those of the heart almost invariably (v. i.) involve the pericardium. Both are usually accompanied and complicated by wounds of other structures as well.

Classifications.—The wounds of the pericardium and heart may be contused, crushed, punctured, incised, and gunshot _ and the wounding body may remain as a foreign body.

The wound may be non-penetrating, penetrating, or perforating.

The origin of the injury may be extrinsic or intrinsic. The latter includes such conditions as pathologic ruptures, to which surgical treatment has not, as yet, been applied.

Operative Treatment.—The first step in the application of operative measures is, of course, exposure of the wounded structures _ and this is accomplished by one of the methods already detailed (pp. 4–33). The technical procedures, as far as the wounds themselves are concerned, are usually _ pericardiotomy, where further access to the heart is concerned than that already secured by the wound _ cardiorrhaphy, or suturing of the heart muscle _ and pericardiorrhaphy, or suturing of the pericardium.

Pericardiotomy, or the incision of the pericardium, may involve simply the extension, by scissors, of the pericardial opening made by the wounding body – or the incising, by knife, of some portion of the pericardium for the purpose of securing satisfactory exposure of the wounded heart. The usual technical procedure consists in grasping the pericardium between two toothed forceps, and, in the case of an already existing wound, the enlargement of it with scissors – or, in the case of making a new opening, of incising with knife, or scissors, between the forceps (Fig. 3284, **a** and **b**).

Pericardiorrhaphy, or the suturing of the pericardium, is usually accomplished by a continuous suture with catgut – and while the pericardium is steadied by two toothed forceps, grasping its structure beyond the limits of the wound – or by traction of the free end of the suture, after the first knotting, and one pair of forceps (Fig. 3285, **a**, **c**).

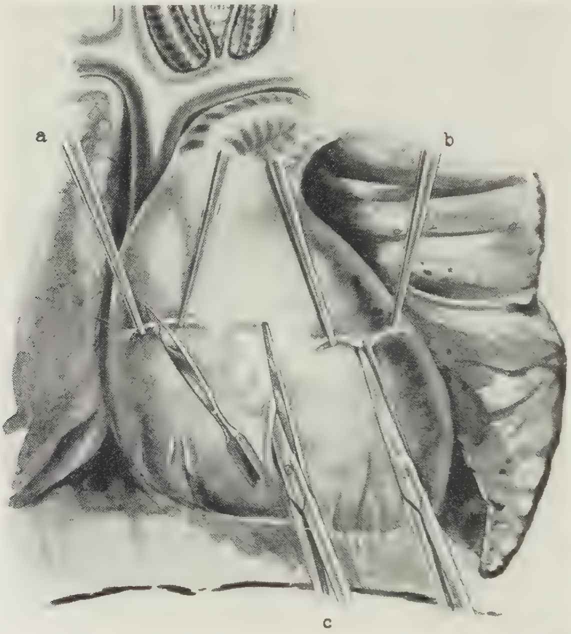


Fig. 3284.—Pericardiotomy: – **a,** Accomplished by means of a knife; – **b,** by scissors – after, in both cases, a loose ridge of pericardium, free from the underlying heart, has been held prominently forward; – **c,** enlarging a pericardial incision by scissors whose under blade is kept in contact with the pericardium.

Cardiorrhaphy, or suturing of the heart muscle, is not so simple as suturing the pericardium, because of the constant activity and greater functional importance of the former organ. Technically, the act of suturing is best accomplished by the grasping of the heart in the fingers of the Surgeon's left hand and the delivery of as much of the organ through the incised pericardium as is required to satisfactorily expose the wound of the organ for suturing – the heart being grasped as shown in Fig. 3285 – holding it with its apex toward the palm, very much as one holds the smaller end of a pear while peeling the larger end – the chief feature of the technic being that the Surgeon's left thumb and index, on opposite sides of the wound, compress the lips together during the act of suturing – so that, simultaneously, the heart is steadied and the lips of the wound are approximated. It will happen, of course, that wounds are sometimes so placed as to make their convenient exposure for manipulation exceedingly difficult – where personal ingenuity will have to aid the Surgeon as to the best method of handling the heart in the individual case. A tractor-suture, introduced near the apex (as shown in Fig. 3285) will often aid in both delivering and steadying the heart _ but every care must be exercised to keep it from cutting through the heart substance through overtension. The most satisfactory suture material is silk _ applied as interrupted sutures, during one diastole _ and tied during another diastole of the heart.

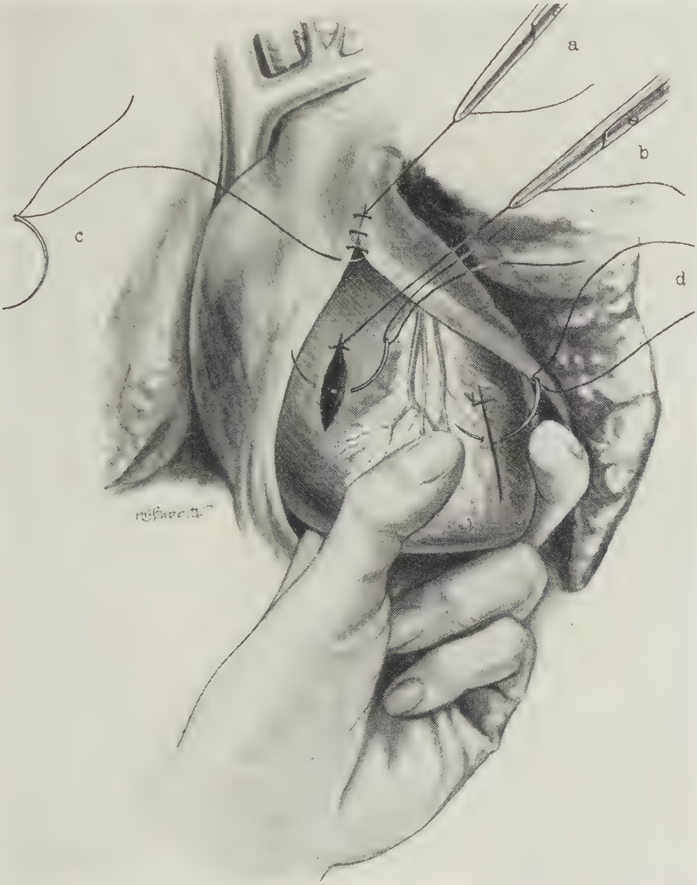


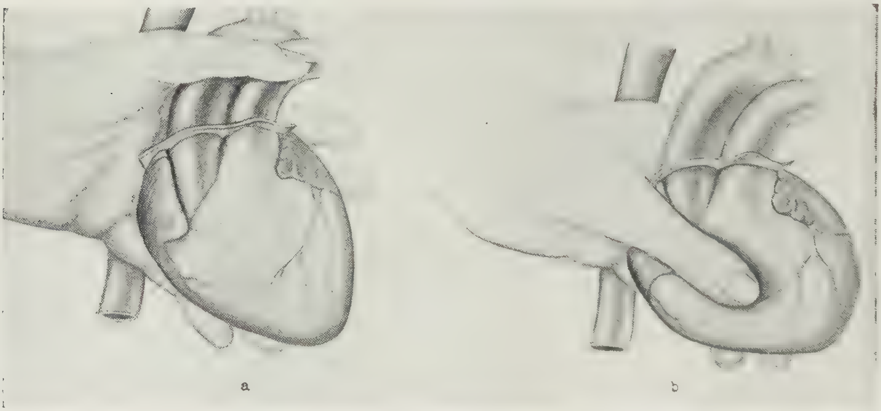
Fig. 3285.—Pericardiorrhaphy and Cardiorrhaphy: _ **a**, **c**, Suturing the pericardium by continuous stitch _ while the site is steadied by traction upon the free end of the suture, after tying the knot at the commencement of the stitch; _ **b**, suturing a non-penetrating wound of the heart, similarly steadied; _ **d**, suturing a penetrating wound of the heart, while the heart is steadied by the grasp of the fingers in the manner shown _ the effect of which is also to arrest bleeding, or the larger part of the direct bleeding from the heart during the suturing, by the compression of the lips of the cardiac wound together.

In performing cardiorrhaphy, silk, upon a fully curved needle, held in a good needle-holder, is used. The needle is quickly, but gently and steadily, inserted during diastole only, and no attempt is made to proceed with the operation except during diastole. The needle enters about 4 to 5 mm. (about $\frac{2}{16}$–$\frac{3}{16}$ inch) from one edge _ penetrates moderately deeply only (never entering the endocardium) _ crosses the gap between the walls of the wound (or may dip beneath the bottom of the wound, if the wound does not entirely penetrate the wall of the heart and there is room beneath it for suture to pass without entering the endocardium) _ and makes its exit at a corresponding point on the opposite side. During a subsequent diastole the thread is drawn through the lips of the wound _ and, during still another, knotted. After the first suture has been placed, gentle traction upon it steadies the heart while placing the others.

When the needle enters the heart there is a momentary stoppage, followed by brief tumultuous action.

Wounds especially difficult to deal with are those which are made downward through the neck, into the base of the heart _ and those made upward through the diaphragm, into the posterior aspect of the heart.

Foreign bodies which are sometimes found within the pericardium are: bullets, broken-off objects, needles (which have found their way from the stomach), and dental plates (which have ulcerated through from the esophagus). The most famous instance of a bullet is, probably, the recorded case of a soldier who carried a bullet in his pericardium from 1812 to his autopsy in 1864.



Figs. 3286 and 3287.—Sauerbruch and Haecker's Method of Compressing the Right Heart for Hemorrhage Control During Operation for Cardiac Wounds: _ **a**, Compression of the right auricle and entering venæ cavæ, between the left third and fourth fingers; _ **b**, counterpressure upon the right ventricle with thumb and first finger _ at the same time dislocating the heart upward and forward thus partially bending it upon itself and its venous supply. Coincidentally, the left thumb and index will often be able to compress the lips of the cardiac wound, so as to aid in suturing.

In order to entirely arrest bleeding from any wound of the heart during suturing, or to materially control it, the technic of Sauerbruch and Haecker is useful, _ the Surgeon applies his left hand to the heart in such a manner as to grasp the right auricle, with its entering venæ cavæ, superior and inferior, between the third and fourth fingers (Fig. 3286, **a**) _ the thumb and first finger grasping and partially compressing the lower aspect of the heart _ while at the same time dislocating the lower part forward and upward (Fig. 3287, **b**), thus tending to bend the large entering veins upon themselves, thereby arresting or very much lessening the blood flow. If it be indicated to continue this maneuver for any length of time, it is safer to allow the circulation to be partially restored intermittently _ at least once a minute.

Wounds of the auricles are generally considered more dangerous than those of the ventricles _ because their walls are thinner, less contractile, and give less aid in the formation of hemostatic thrombosis.

Wounds of the thinner right ventricle bleed more freely and more continuously than those of the left _ and, therefore, are more serious. Wounds of the thicker left ventricle bleed less furiously, and more intermittently, and their more marked columnæ carneæ favor conservative thrombosis.

Wounds which open up into the heart cavities are, naturally, more dangerous than those which only involve a part of the thickness of the cardiac wall _ and wounds of the interventricular septum are less dangerous than penetrating one of the walls.

If important branches of the coronary arteries be wounded, subsequent important degenerative changes in the heart muscle may occur.

It is generally well to open the pericardial sac to its full length, in the axis of the heart _ from apex to base _ thus giving the freest approach for the quickest accomplishment of the object of the operation.

By practising traction, with clamp forceps, upon the margins of the pericardial wound, the heart can usually be delivered into a more favorable position for manipulation, and be brought nearer the level of the wound.

Silk, preferably vaselined, is the best material for heart suturing. Chromic catgut is often employed _ but is not so reliable.

In superficial, non-penetrating heart wounds, a curved surgical needle, held in a small needle-holder, and armed with lubricated silk, is carried through first one lip of the wound, and then the opposite, while each is steadied, in turn, with forceps, the amount of myocardium included within the suture being sufficient to forego any chance of tearing out. Preferably during the diastole of the heart (if recognizable), these successive interrupted sutures are tied with a friction-knot. The passage of the first suture is always the hardest. When knotted, it sometimes renders admirable steadying service as a temporary tractor.

In suturing a penetrating heart wound the suture passes down to the endocardium, but the penetration of the endocardium is carefully avoided. To accomplish this with certainty it is well to carry the suture through the myocardium of one side, and bring it out at the bottom of that side, just above the endocardium _ and then, reversing it, enter the opposite side, just above the endocardium, and proceed in the opposite direction.

It is practically necessary to adjust the tying of sutures so that they will subsequently be neither too loose nor too tight. Sometimes, sutures have cut their way out. This may even happen during the operation _ leaving a cross-cut wound most difficult to repair. Matas has suggested, under such circumstances, the possibility of excising the margins of the wound, thus left ragged, and bringing the new edges together with mattress-sutures.

The peculiar circumstance has been recorded of a man's being shot in the recumbent position _ the ball entering one of the large vessels _ and thus passing into and wounding his heart without wounding the pericardium.

Wounds of the pericardium and heart may be associated with wounds of any or many of the structures not only of the thorax, but of the neck, or abdomen as well _ each complication requiring to be met upon its own grounds.

It may be something of a guide to remember that darker bleeding is more indicative of hemorrhage from the right side of the heart _ while redder bleeding is more apt to come from the left side of the heart.

Often, on entering the pericardium, in search of the cardiac wound, one is at once confronted with considerable wound confusion _ such as a distended pericardium _ clots _ gushing blood _ foamy froth, from admixture with air from wounded pulmonary bronchi _ and all of these must be gotten away, by gauze sponging and suction drainage, before any deliberate examination can be made _ and be kept away, by digital compression of the heart and clamping of pleural wounds, during the carrying out of any manipulation.

Sometimes a wound in the substance of the heart, especially of a ventricel, can be controlled temporarily by finger plugging, or by a gauze tampon.

Effort should be made to prevent the suction of air into the heart through the cardiac wound.

Burghard states, _ "It has been recommended to pass stitches into the left ventricle during systole, and into the right, during diastole, but the physiologic correctness of this advice has been called in question, and the practicability of carrying it out appears very doubtful."

Any damage done to the coronary circulation must be repaired as well as possible.

General anesthesia may have to be withheld during operation because of a condition growing increasingly worse. Where it can be carried out, it may be of great advantage to work, from beginning to end, under analgesia _ but, all in all, the minimum amount of ether which will control the patient is the practice most frequently followed.

It is not to be forgotten that death may be caused by the amount of blood imprisoned within the pericardium being so great as to compress the heart to the point of arrest _ which, by the proper incision of the pericardium in time, might have been prevented.

Sauerbruch and Haecker advise suturing the heart under 3 mm. Hg. pressure _ and to complete the operation under from 7 to 8 mm. Hg.

There is hardly any excuse for the wounding of the pleura during manipulations, in average conditions _ a mishap which may not be serious, but certainly adds one more complication to be met.

Heitler suggested the painting of the heart with cocain solution before beginning manipulations _ to prevent reflex arhythmia.

It is needless to say, that if the foreign body is encountered which has made the wound, it is withdrawn during the operation.

Sauerbruch and Haecker state as an additional argument for the use of differential pressure methods (apart from the indications on general principles) that in 80 per cent. of heart-wound cases the pleura is also wounded, _ and, further, that it increases oxygenation _ replaces the disturbing respiratory movements _ makes the heart easier to suture by elevating it _ and aids in demonstrating lung wounds. Sauerbruch considers that low pressure does not increase the hemorrhage.

If the Assistant uses the first tied suture as a tractor, in his left hand, he may further aid the Surgeon by pressing the tip of his right index-finger over the wound, in the interval between the passage of each stitch _ lifting it for each passage of the needle.

The ligation of wounded coronary vessels is not incompatible with life, as formerly considered.

It is generally reported that it is impossible to distinguish cardiac systole and diastole during the tying of sutures.

While the wound of the heart is usually closed with interrupted vaselinated silk sutures, wounds of the pericardium may be closed with interrupted chromic gut stitches.

The question of drainage has caused much thought and discussion. The summary of views seem to hold that no drainage of pericardium nor of the wound is indicated in the simpler and in non-infected cases _ while, in the more complicated, in the definitely infected, and in those reasonably supposed to be infected, it is indicated to conduct down to the pericardial opening a non-irritating, non-projecting drain and out through the wound.

Guibal collected 66 cases, in which the sutured pericardium and pleura were drained in 56 cases, and not drained in 10; 8 out of the 10 recovered, 5 without infection, and 3 with infection. Tscherniachowski reported 90 cases, in 42 of which the pericardium was closed 42 times, without drainage, and with a mortality, from pericarditis, of 46.87 per cent.

Infective pericarditis, or pleuritis, or both combined is, according to Guibal, responsible for 45.4 per cent. of the deaths following cardiorrhaphy.

Matas sums up the question of drainage as follows: _ That each case must be decided upon its own merits, _ that it is safe to close pericardium and pleura where it is believed primary infection is eliminated, _ that where asepsis is doubted, it is safer to drain the pericardium, and to close the pleura, _ and that where sepsis is suspected, it is safer to drain both. He recommends, with Rehn, the conduction of a rubber-tube drain to the depths of the pericardial sac _ in the most dependent part of the sac, and below the heart _ at the internal inferior angle. After closing all pleural wounds, he drains the pleural cavity in its most dependent position, posteriorly, without admitting air.

Temporary drainage of the pericardium is indicated, according to the views of some, to conduct away the serous collections which are apt to occur in the pericardium following operation _ and which are capable of dangerously compressing the heart.

Some operators advise the leaving of a small extent of the pericardial incision unsutured in its lower part, so that any exudate may empty itself outward _ and then provide a superficial drain from the skin down to, but not into, the pericardial sac, for the outward conduction of serous effusions.

Burghard states that it appears safest to leave a drainage-tube in the pericardium, as pericarditis so frequently follows heart wounds. He considers it time to make provision for the drainage of the pleural cavity when the necessity arises _ rather than to methodically drain it.

Kocher states, _ "If the operation is aseptically carried out, the pericardium and pleura should be immediately stitched up, while a drain is necessary only in infected cases."

Saline infusion is often carried on during operation _ or immediately after.

In the after-care of the patient, the hypodermic use of some principle of digitalis, combined with strychnin, and with morphin and atrophin, is useful.

DIRECT MASSAGE OF THE HEART

Description.—Direct cardiac massage consists in the immediate rhythmic compression of the heart muscle by the hand, applied immediately to the heart, or, at most, through only an intervening diaphragm. Several methods of accomplishing this are available.

Indications.—The chief condition under which direct cardiac massage has been employed, has been the syncope of anesthesia _ 38 of the 46 cases of its use, collected by Cackovic, were of this nature. It has also been used in laryngeal or tracheal asphyxia, the asphyxia of the newborn, some cases of pulmonary embolism, suicide from hanging, and the like.

To be effective, its use, naturally, must be as quickly after cessation of heart action as possible _ and the successful cases have borne a direct relation to the promptness with which the aid has been supplied. Kuettner states the length of time after which massage was begun in a series of cases as follows: _ the method was applied fifteen times, within five minutes, in 37 cases, _ four times, within five to ten minutes, _ seven times, after fifteen minutes, _ six times, after fifteen to thirty minutes, _ three times, after thirty to forty-five minutes, _ once, after one hour, _ and once, after two hours.

Physiology of Direct Cardiac Massage.—Matas states: _ "Massage acts on the heart by: (1) Emptying mechanically the distended cardiac chambers, _ (2) Creating an artificial circulation, _ (3) Keeping up the nutrition of the myocardium through the coronary vessels, _ (4) Artificially pumping blood to the brain and correcting the circulation of the medulla and central organs of the nervous system, _ (5) Stimulating the nervous energy of the cardiac muscle." He states, _ "Massage can accomplish no good after _ (1) Coagulation of the blood in the heart has taken place, and (2) the myocardium itself has lost all contractility by postmortem coagulation, _ (3) Whenever the respiration fails, or the central automatic reflex centers of the medulla are permanently changed."

Results of Direct Cardiac Massage.—Kuettner reports the following results in the following number of cases: _ successful cases, 10, _ death, after the return of heart contractions for several hours, 9, _ death, after a brief return of heart action, 9, _ complete failure, 20.

Methods of Employing Direct Massage of the Heart.—These are three: _ The transthoracic method (which yielded 2 of the 10 successful cases mentioned above); _ The trans-abdomino-trans-diaphragmatic method (which yielded none of the successful cases); _ The trans-abdomino-sub-diaphragmatic method (which yielded 8 of the 10 successful cases). These will be briefly described: _

Transthoracic Method of Direct Cardiac Massage.—The quickest method of approach is through the major intercostal thoracotomy incision, made between the left third and fourth ribs (in the third intercostal space). Approach by thoracoplastic flaps has also been used _ flaps including the third and fourth or fourth and fifth costal cartilages and ribs. The majority of operators incise the pericardium and grasp the naked heart _ while a smaller number grasp pericardium and heart together, without opening the former. If the pericardium were distended by blood, it would necessarily have to be incised, for both free play of the heart, and effective manipulation of the operator. The pleura is usually opened in the act. The heart is rhythmically compressed, between thumb, upon one aspect, and the first fingers, upon the opposite, from forty to sixty times per minute, and imitating the cardiac systole and diastole.

Trans-abdomino-trans-diaphragmatic Method of Direct Cardiac Massage.—An incision is made into the peritoneal cavity, through the median abdominal wall, extending from the ensiform cartilage, toward the umbilicus _ the stomach and liver are depressed _ and an incision is made in the diaphragm, beginning at its dome, and passing from above, on the right, downward, in the direction of the heart, toward the left _ extending 4 to 5 cm. ($1\frac{9}{16}$–2 inches) in length _ carefully controlling the section. The incision is sometimes begun with the knife and ended with scissors. Mauclaire advised approach by incision _ and Poirier, by boring the thumb or finger through the diaphragm. The pleura is usually not opened.

Trans-abdomino-sub-diaphragmatic Method of Direct Cardiac Massage.—This is the simplest and quickest method _ two incontestable advantages _ and, besides, is the method which has brought about the greatest number of recoveries. It is the method of choice _ even in those cases where the abdominal cavity does not happen to be open, in the course of the original operation. A median abdominal incision is made into the abdominal cavity, in the epigastric region, large enough for the hand to enter _ which is carried backward and upward, in contact with the left lobe of the liver and stomach, to the middle of the diaphragm _ where the heart is seized, through the relaxed diaphragm, between the thumb and first fingers, and rhythmically compressed.

The heart is seized above the apex, so as to compress the ventricles _ at the rate of from twenty to forty times per minute. Sometimes the heart will respond immediately _ in other instances, not for five _ ten _ or fifteen minutes. It has happened that the heart has not been located by the subdiaphragmatic method _ necessitating the conversion of the operation into a transdiaphragmatic one. In some instances bimanual compression of the heart can be brought to bear, in the subdiaphragmatic technic _ compressing the heart between the hand within under the diaphragm, and a hand without, upon the precordial region of the chest wall.

The object of the compression is to empty the heart _ and, in the interval, to allow it to refill. Artificial respiration should be maintained at the same time _ and both should rather be continued too long than be abandoned too soon. If success follows effort, a feeble thrill or flutter is first detected _ which gradually increases in rhythm and volume.

CARDIO-LYSIS (OR THORACO-LYSIS PRÆCORDIACA) FOR CARDIO-SYMPHYSIS DUE TO CHRONIC ADHESIVE MEDIASTINO-PERICARDITIS

BRAUER'S OPERATION

Description.—The subjects of pericardio-symphysis and cardio-symphysis, and pericardio-lysis and cardio-lysis were gone into at some length at p. 17 _ and will not be again discussed here.

From what was there said, it would seem that the expression, "mobilization of the heart for cardio-symphysis," would be better than "cardio-lysis" _ for the heart is not literally freed from its adhesions, but made movable, along with its unsevered adhesions. Matas suggests "cardioschesis."

Upon the ground that the in-pull of the chest wall during the systole of a heart which, together with its pericardium, was fused by adhesions to the anterior thoracic parietes, represented a harmful degree of labor on the part of the heart muscle, Brauer, recognizing the impossibility of literally severing these inter-pericardial (cardio-pericardial) and inter-pericardio-thoracic (pericardio-thoracic) adhesions, suggested accomplishing some degree of relief to the heart by excising the osteo-cartilaginous portion of the chest wall overlying the adherent aspect of the heart _ thus substituting a soft, elastic, yielding wall which would comfortably and readily follow the cardiac movements, for a rigid one that would not. Further, the heart is thus allowed to fall back into the thoracic cavity, thereby relaxing whatever other lateral and posterior adhesions which may exist. The procedure represents the best technic in use for cardio-symphysis.

The amount of osteo-cartilaginous tissue removed varies _ but should err on the side of an over, rather than an under, amount _ as Brauer especially emphasizes. The fourth, fifth, and sixth left costal cartilages and ribs, from the left sternal margin to either the anterior mammary, or anterior axillary line, together with the perichondrium and periosteum of their outer aspect, and upper and lower borders, are removed _ and so sometimes a part of the sternum _ the exposure being through a thoracoplastic flap of soft parts.

Position.—Dorsal, with elevated shoulders.

Landmarks.—Sternum, and fourth, fifth, and sixth costal cartilages and ribs _ and anterior mammary, or anterior axillary line.

Analgesia-anesthesia.—Either may be used, largely dependent upon the patient _ the latter being preferable. The operation is not a difficult one.

Incisions.—A flap of soft parts is outlined upon the left side of the thoracic wall, planned so as to hinge backward (Fig. 3288). The upper incision will pass in the interspace above the fourth rib _ and the lower, in the interspace below the sixth rib _ the incisions beginning over the left margin of the sternum, and ending, usually, in the anterior axillary line. The anterior incision connects the upper and lower incisions, and passes down over the left outer aspect of the sternum.

Operation.—The sternal incision is deepened to the periosteum _ unless the left margin of the sternum is to be also excised, as is sometimes done (and is indicated when the heart is adherent to the sternum). The horizontal incisions pass down to the intercostal muscles. The flap thus outlined, consisting of all the soft parts, skin, fascia and muscle, down to the indicated level, is raised _ and turned backward. An incision is now carried through the center of the perichondrium of the cartilages, and through the periosteum of the ribs _ through the entire lengths of the three ribs exposed. These axial incisions through the perichondrium and periosteum are crossed at each end by a cut across the cartilages and ribs at a right angle to the axial cut _ which will greatly add to the ease of subperichondrially freeing the cartilages, and subperiosteally freeing the ribs. At the sternal ends, then, the cartilages are

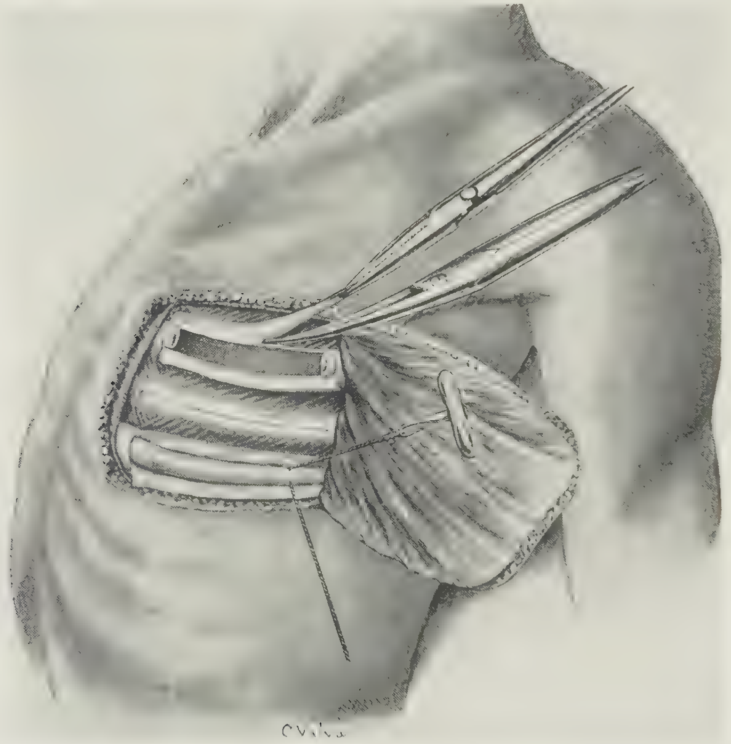


Fig. 3288.—Cardio-lysis (or Heart Mobilization) for Cardio-symphysis, Due to Chronic Adhesive Mediastino-pericarditis _ Brauer's Operation; _ The thoracoplastic flap of overlying soft parts has been raised and turned back. Over the fourth rib the perichondrium and periosteum have been axially divided, transversely cut at the ends _ and, following the removal of the rib and cartilage, all of the perichondrium and periosteum, except the bed, is being removed by forceps and scissors. Over the fifth rib the incisions have simply been carried. The sixth rib and cartilage are being excised by a Gigli saw. The amount of cartilage and bone structure here removed is less than the usual amount excised.

divided _ and, at the outer ends, the ribs _ after the perichondrium and periosteum have been carefully separated from the entire circumference of the cartilages and ribs by means of a curved periosteal elevator. The division is more surgically accomplished by means of a Gigli saw _ but may be done with bone-cutting forceps (which crush the parts through instead of cutting them through). When the cartilaginous and bony parts of the ribs are removed, the only part of the operation which is difficult remains _ the separation of the perichondrial and periosteal beds. It is, theoretically, indicated to remove all of the perichondrium and periosteum _ but, practically, only an upper and a lower ribbon of perichondrium and periosteum will be removed from each bed _ the upper ribbon including one-half of the anterior layer and the upper border _ and the lower ribbon, the other half of the anterior layer and the lower border _ as shown in the illustration. This is the process usually adopted _ simply because it is very difficult to excise three such lengthy beds as the posterior layers represent, without somewhere wounding the pleura, which is immediately beneath, with only the thin endothoracic fascia intervening _ an accident which is due to be followed by pneumothorax, and may be accompanied by infection of the pleural cavity. If one were sure of being able to accomplish it, however, and fairly sure of a pathologically thick soft wall beneath the perichondrium and periosteum, there is no reason why it might not be undertaken. But it is risky _ and, apparently, unnecessary _ for experience has shown that if bone substance is reformed at all, it may be a very long time in doing so _ and then be only a thin line of bone at the bottom of a bed already sunken in. Finally, the soft flap is turned back into place and sutured by buried and superficial stitches. A temporary drain is placed in a dependent portion of the wound, to carry away the wound exudates of the first few hours.

Comment.—In the great majority of cases operated upon the final results have been distinctly good _ and the operation is of unquestionably great value _ independently of the fact that there is no other better course to be suggested.

EXPERIMENTAL OPERATIVE SURGERY OF THE HEART

As Kuettner has put it, "the ground has been broken for operative interference in heart valve defects, heart aneurysm, and heart suppuration."

Carrel states, in discussing "some method for the treatment of valvular diseases and localized sclerosis of the coronary arteries: Theoretically, many operations can be performed on the heart; incision and dilation of stenosed valves, cuneiform resection and stenosis of the upper part of the ventricle in case of mitral insufficiency, curetage of endocardiac vegetations, grafting of new vessles on the auricle and ventricle, collateral circulation between two cavities of the heart, aorto coronary anastomosis, etc." Further, he writes that _ "plastic operations on the heart are not very much more difficult than on any other part of the body. But to perform the operations without disturbing in an irreparable manner the functions of the nervous system and of the heart itself is a very complicated problem. The technic of these operations is far from being completely developed."

CHAPTER LVIII

OPERATIONS UPON THE GREAT INTRATHORACIC VESSELS OF THE HEART

OPERATIONS UPON THE GREAT INTRATHORACIC VESSELS OF THE HEART, p. 46.
OPERATIONS FOR WOUNDS OF THE GREAT VESSELS OF THE NECK, Vol. II, pp 92–117.
OPERATION FOR EMBOLISM OF THE PULMONARY ARTERIES (Trendelenburg), p. 46.

OPERATIONS FOR WOUNDS OF THE GREAT VESSELS OF THE HEART

THE repair of injuries to the large intrathoracic vessels differs in no respect, as to principle, from similar procedures upon vessels elsewhere — which have been described in Vol. II, pp. 3–45.

The practical differences, however, are great — and these are manifested in two directions,—the far greater magnitude and functional importance of the large vessels within the thorax — and the difficulties and dangers of their exposure.

The general features of intrathoracic surgery have been given (Vol. III, pp. 781–797) and apply equally to intrathoracic vascular surgery and to intrathoracic visceral surgery.

The wounded vessels may be incidentally encountered in the course of some other operation — and are then further exposed and dealt with as indicated.

When it is undertaken to deliberately expose these vessels, some method of approach is usually adopted as may be called for in the exposure of the superior or middle mediastina (Vol. III, pp. 950–961) — within which the great intrathoracic vessels lie.

OPERATION FOR EMBOLISM OF THE PULMONARY ARTERIES

TRENDELENBURG'S OPERATION

Description.—The operation consists in the removal of venous embolic thrombi from the pulmonary artery, or from its immediately adjacent right or left branches (but not beyond). Necessarily, but comparatively few cases will come under operation — as attempt at relief should be undertaken within fifteen minutes — and secured within the next fifteen — and, further, the operation is hardly feasible outside of a well-equipped hospital. It is especially desirable to have apparatus for differential pressure on hand. Circulation in the pulmonary artery and aorta is temporarily controlled.

Cases of pulmonary embolism fall into three groups,—one, in which death occurs almost immediately,—another, in which the emboli are small, and spontaneous recovery often occurs,—and a third, in which life is usually prolonged from ten to sixty minutes. It is especially in the last group of cases that Trendelenburg advises operation. Naturally, it may be difficult to decide the indication for operation, other than upon principle, and the desperateness of clinical phenomena, in individual cases. The writer knows of no reported case of recovery from operation, although life has been prolonged varying lengths of time.

Anatomy of the Parts Involved.—The pulmonary artery passes upward from the heart behind the left lateral aspect of the sternum — beginning behind the left third chondrosternal articulation — and bifurcating into right and left pulmonary branches opposite the upper border of the left second costal cartilage _ its trunk, therefore, extending from the upper border of the third to the lower border of the first rib. The visceral layer of the pericardium is reflected upon, and envelops the pulmonary artery, aorta, and vena cava. Upon excising the left second and third costal cartilages, and partially collapsing the left lung, the outline of the pulmonary artery is usually seen _ but it is covered by pericardium and pleura, and often so hidden by enveloping fat that it may not be easy to recognize except by palpation. The pericardial sac extends upward as far as the beginning of the left subclavian artery _ and over this portion of the sac the left phrenic nerve courses obliquely downward toward the apex. Upon incising the pericardium in this region, access is given to the pulmonary artery, to the left, and the aorta adherent to it, between it and the vena cava (which is to the extreme right, out of the field). Behind these vessels, the pericardium is reflected upon the auricles _ thereby forming, posterior to the great vessels, the sinus pericardii _ and it is because of this sinus, or space, and through it, that one can generally pass a finger between the left aspect of the pulmonary artery and the pericardium, and, hugging the pulmonary artery and adherent aorta, come out again upon the right aspect of the aorta _ and through which is conducted the temporary tension ligature to control the pulmonary artery and aorta during operation, as shown in Fig. 3291.

Preparation.—As for exposure of the heart. It is especially desirable to have means for differential pressure at hand. Owing to the very few minutes available for operation, there is but little time for formal preparation _ and, except in a hospital, where relative readiness is usually available, the operation is rarely undertaken.

Position.—Supine, with elevated and prominent chest.

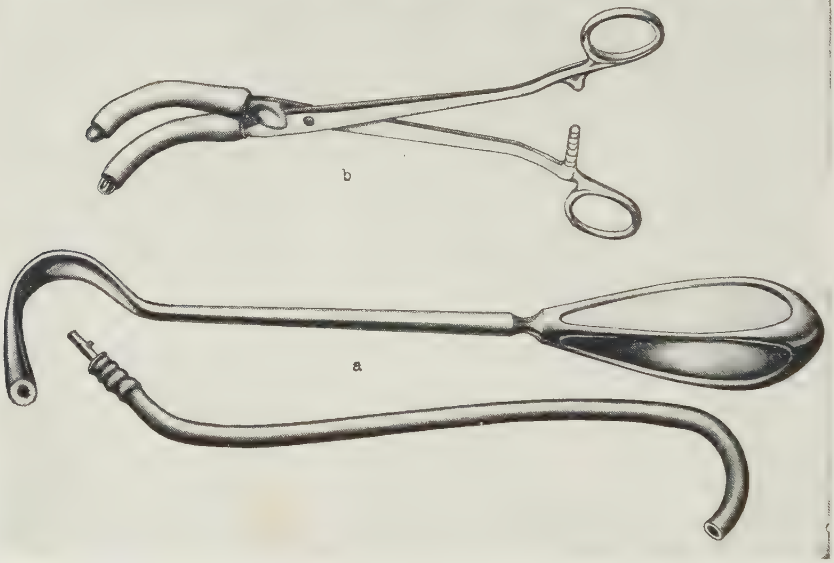
Landmarks.—Left sternal border, and articulations of the second and third costal cartilages.

Anesthesia-analgesia.—Most careful ether, or nitrous oxid and oxygen anesthesia is indicated, as far as the operation, in general, is concerned _ but the patient's condition may forbid anything but analgesia.

Incision.—A transverse incision is made outward upon the left second rib, beginning over the sternum and extending over the rib for about 12 cm. (4¾ inches). To this, a vertical incision is added, extending down the outer surface of the left aspect of the sternum, from the first to the third left ribs. Two right-angled flaps are thus outlined, one hinging outward and upward _ and the other outward and downward.

Operation.—The two triangular flaps of all the soft parts overlying ribs and intercostal muscles are quickly raised and retracted away from the field. The second cartilage and rib are excised, for the full length of the incision. A somewhat shorter extent of the third cartilage and rib is also excised. The internal mammary vessels are displaced mediad. The pleura is next incised, to the whole extent of the incision, and kept well out of the field by retractors. When the pleura is incised, the lung collapses, if no differential pressure method be in use _ and if one be employed, partial collapse is purposely allowed, as an aid in the operation. By the collapse of the lung the pericardium is freely exposed _ and the outline of the enclosed vessels is demonstrable. The left phrenic nerve should be recognized _ and should be kept to the left of the operation field. The pericardium is seized between two toothed forceps and drawn forward, while being incised axially, and carefully to the median side of the left phrenic nerve _ after which the margins of the pericardium are grasped by clamp-forceps and drawn to either side.

The pulmonary artery and aorta are thus brought into the field. At this stage the special crook-shaped probe and ligature-carrier (Figs. 3289 and 3290) comes into play. Its beak is introduced between the left aspect of the pulmonary artery and the left boundary of the pericardium _ and made to insinuate its way around the pulmonary artery and aorta, hugging them all the while, until it traverses the pericardial sinus, and emerges immediately to the right of the aorta. The attachable rubber tube tension-ligature is then adjusted to the carrier _ when it is drawn back in the reverse direction _ with the rubber ligature after it _ keeping as near to the heart as possible, where the pericardial sinus is roomiest. It is of no great consequence if this special instrument be not at hand. An ordinary uterine sound, bent to the proper curve, will suffice. This is first passed, after which the rubber tube is slipped over its bulbous end and tied _ and follows the sound in its withdrawal in reverse direction _ when it may be cut free of the sound.



Figs. 3289 and 3290.—Special Instruments Used in Trendelenburg's Operation for Pulmonary Embolism: _ **a**, Trendelenburg's combined sound and rubber tube carrier; _ **b**, artery-clamp for controlling the incised pulmonary artery.

An Assistant takes charge of the rubber tourniquet, which should compress the pulmonary artery and aorta at about the level of the valves, and by slight tension upon them can lift the pulmonary artery (and adherent aorta) sufficiently far forward to control the circulation (Fig. 3291). No control of the vessels is exercised until just prior to incising the pulmonary artery. Prior to incising the artery, the visceral layer of the pericardium should be freed from the wall of the vessel, so that its presence will not interfere with the suturing of the opening in the artery at the end of the operation.

When all is in readiness (Fig 3291), and the blood flow temporarily controlled by outward tension upon the arteries, which also lifts them into a better exposure for operation, the Surgeon makes an incision through all of the coats, in the long axis of the pulmonary artery, directly into its lumen. He then promptly carries a pair of curved forceps of appropriate size (on the polypus-forceps, or dressing-forceps order, Fig. 3293, **c**) boldly into the cavity of the artery _ searching for the embolus in both the main trunk and its right and left branches _ extending the search, if necessary, for 6 to 8 cm. ($2\frac{6}{16}$–$3\frac{1}{8}$ inches). If found, the embolus is seized and drawn out _ and additional search expeditiously made for more, if indicated.

In order to promptly re-establish the blood flow (within forty-five seconds, if possible), the artery does not immediately receive its final suturing. The limbs of a pair of special weak-springed, sharp-toothed forceps, with teeth directed outward (Fig. 3292, **d**), while compressed together, are inserted through the incision, into the lumen of the pulmonary artery _ which, upon expansion, by relaxation of pressure, cause the outwardly directed pointed teeth to engage themselves in the lumen of the artery _ thus securing means for simultaneously drawing both small lips of the arterial wound outward to the same extent, and parallel with each other (Fig. 3294). While the lips of the arterial wound are thus held (all done as quickly as is reasonable, up to this stage), the blades of a special curved clamp-forceps are applied against the outer coat of the two lips of the arterial wound thus ridged up _ and compress them together in such a way that a large part of the lumen of the pulmonary artery is left free for the immediate transmission of blood to the lungs, while the lips of the arterial wound to be sutured lie well exposed, entirely outside

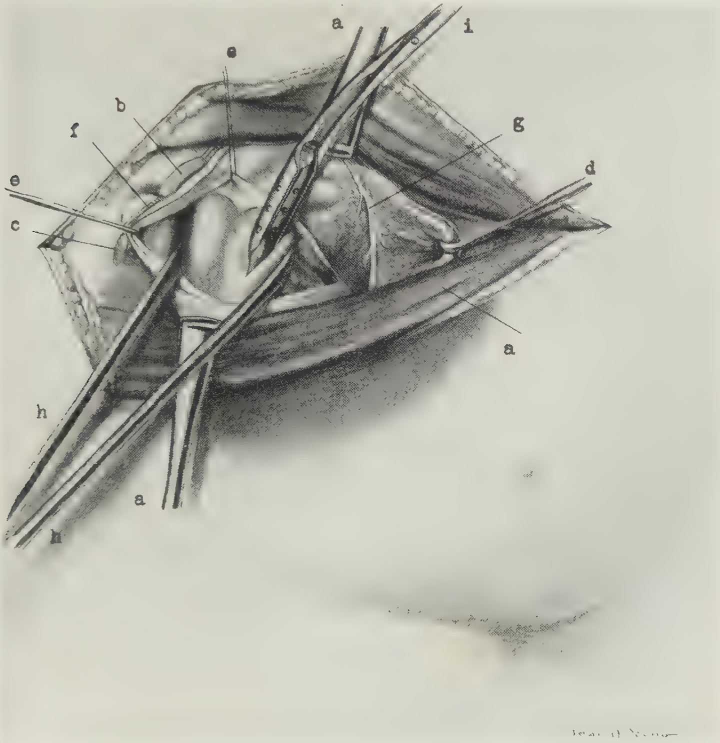
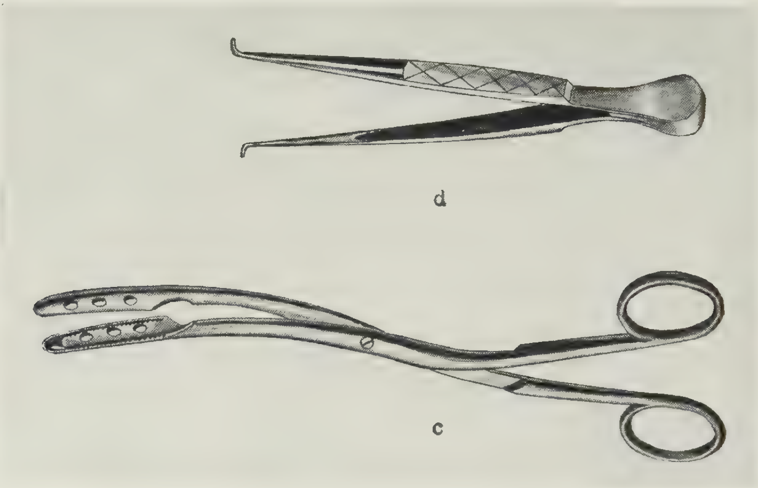


Fig. 3291.—TRENDELENBURG'S OPERATION FOR PULMONARY EMBOLISM _ I; _ Withdrawing the clot: _ **a, a, a,** The retracted margins of the wound; _ **b, c,** sternal aspect of the excised second and third costal cartilages; _ **d,** outwardly displaced left lung, with its unopened pleura; _ **e, e,** incised and retracted pericardium; _ **f,** internal mammary vessels; _ **g,** phrenic nerve and pericardio-phrenic vessels; _ **h, h,** rubber tube around the pulmonary artery and aorta; _ **i,** polyp-forceps extracting the clot from the incised pulmonary artery.



Figs. 3292 and 3293.—Special Instruments Used in Trendelenburg's Operation for Pulmonary Embolism: – **c,** Polyps forceps, for extracting thrombi from the pulmonary artery, or heart; – **d,** forceps acting upon expansion, with outwardly directed teeth, for maintaining parallel traction upon the lips of the incision while suturing the pulmonary artery.

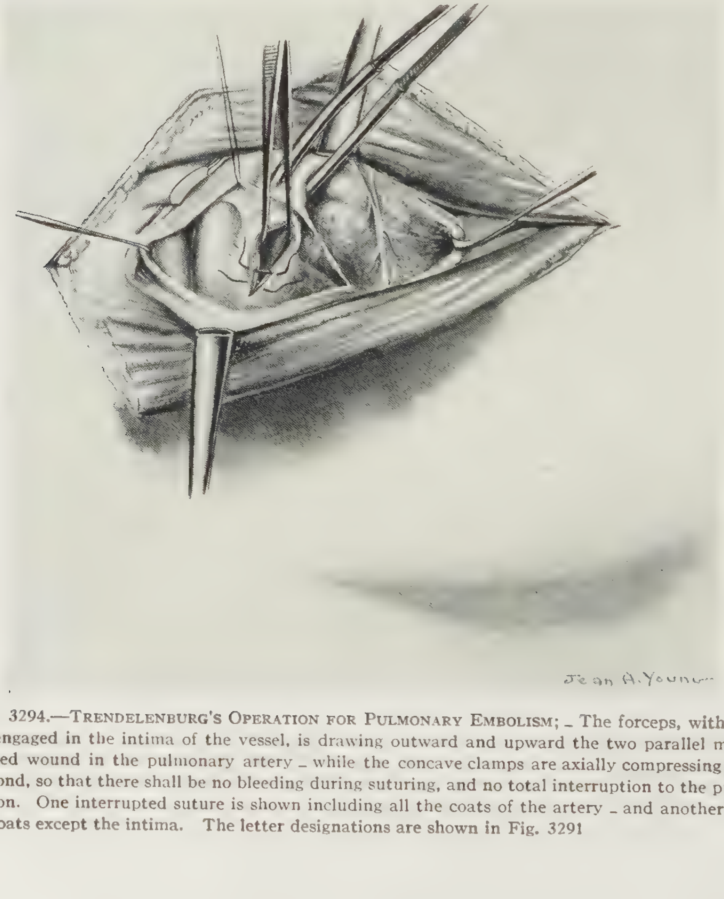


Fig. 3294.—Trendelenburg's Operation for Pulmonary Embolism; – The forceps, with reversed points, engaged in the intima of the vessel, is drawing outward and upward the two parallel margins of the incised wound in the pulmonary artery – while the concave clamps are axially compressing the wall just beyond, so that there shall be no bleeding during suturing, and no total interruption to the pulmonary circulation. One interrupted suture is shown including all the coats of the artery – and another, piercing all the coats except the intima. The letter designations are shown in Fig. 3291

of the concave grip of the forceps _ and may be sutured in relative leisure (as compared with the speed at which the work must be carried on up to this point).

Proceeding henceforth with less haste, though still with expedition, the arterial wound is sutured _ while the blood is flowing through it, beyond the area compressed by the curved clamp. The suturing is best done by means of vaselined silk, carried upon a round needle, and placed as interrupted sutures. Sauerbruch recommends that the arterial sutures include the intima. As the margins of the arterial incision project above the blades of the clamp, they are readily manipulated by fine forceps in the act of suturing. Finally, the clamp is relaxed, and any insecure area of arterial suturing is reinforced. The rubber tourniquet is relaxed from the moment the arterial wound is clamped off, so as to allow of the blood flow beyond it _ but had probably better not be withdrawn until the line of suturing is tested after the relaxation of the clamp _ in the event that bleeding should have to be again controlled while the suturing is being reinforced.

The incised pericardium and pleura are closed by sutures. The soft flap is turned back into place, and sutured by buried and superficial stitches.

Comment.—The operation is difficult, independently of the little time available _ bleeding from the pulmonary artery is apt to be considerable _ and the vessel suturing is hard. Thrombi are very apt to be left behind (as shown by autopsy) _ the removal often being incomplete. The dangers from infection are especially great in operations carried on in the hurried manner in which these must be.

Laewen and Seviers, as a result of their researches, declare that not more than forty-five seconds should be consumed in incising the pulmonary artery, extracting the embolus, and clamping the vessel so that circulation may be re-established during the suturing of the vessel wall.

Animals have recovered from the operation, and while there is no human case, known to the writer, to have recovered, one lived fifteen hours _ one, thirty-seven hours _ and another died five and a quarter days after operation, from suppurative pleuritis.

Artificial respiration should be maintained after operation until normal breathing is established, and maintained. Cardiac massage has been resorted to, to restore normal heart action, which is the crucial point. Intratracheal oxygen inflation is sometimes indicated.

CHAPTER LIX

OPERATIONS UPON THE THORACIC PORTION OF THE ESOPHAGUS

Surgical Anatomy, p. 52; General surgical considerations, p. 52.

Anterior Transpleural Exposure of the Upper Part of the Thoracic Esophagus (and Posterior Mediastinum) Through an Anterior Mediastinal Thoracoplasty, with Resection of the Esophagus (Sauerbruch), p. 53.

Posterior Extrapleural Exposure of the Thoracic Esophagus (and Posterior Mediastinum) Through a Posterior Mediastinal Thoracoplasty (Enderlen), p. 55.

SURGICAL ANATOMY OF THE THORACIC PORTION OF THE ESOPHAGUS

Given in Vol. III, p. 617 in connection with the operations upon the cervical portion of the esophagus.

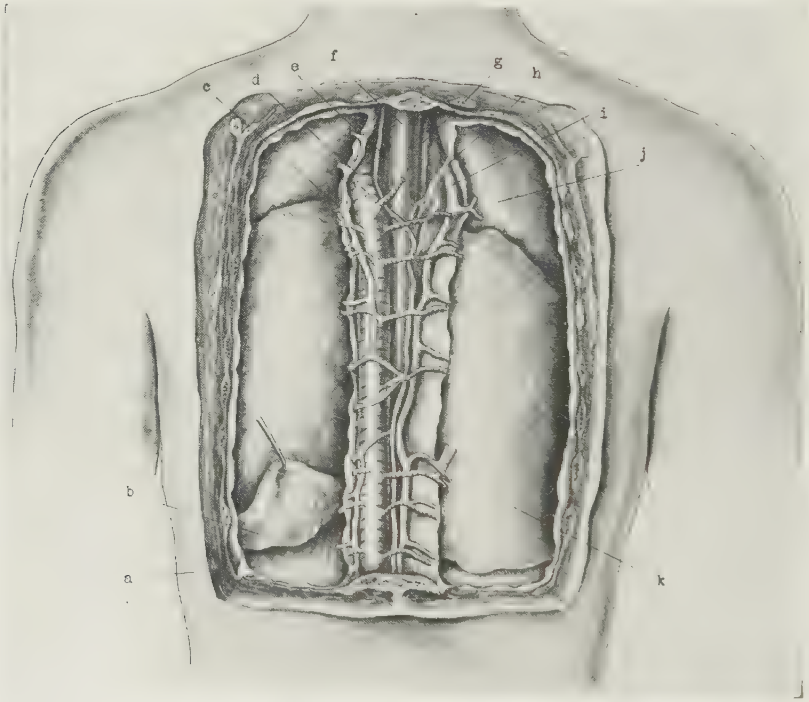


Fig. 3295.—View of the Posterior Mediastinal Structures, as Seen from Behind, and After the Removal of the Spine: — **a,** Diaphragm; — **b,** lower lobe of left lung, turned upward and outward; — **c,** vena azygos minor; — **d,** aorta; — **e,** thoracic duct; — **f,** esophagus; — **g,** trachea; — **h,** branch of posterior pulmonary plexus; — **i,** vena azygos major; — **j,** upper lobe of right lung; — **k,** lower lobe of right lung — (the middle lobe having no demarcation this far posteriorly). (Redrawn from various Anatomies, chiefly from Deaver.)

GENERAL SURGICAL CONSIDERATIONS

Given in Vol. III, p. 618 under the operations of the cervical esophagus.

ANTERIOR TRANSPLEURAL EXPOSURE OF THE UPPER PART OF THE THORACIC ESOPHAGUS (AND POSTERIOR MEDIASTINUM), THROUGH AN ANTERIOR MEDIASTINAL THORACOPLASTY, WITH RESECTION OF THE ESOPHAGUS

SAUERBRUCH'S OPERATION

Description.—While the resection of the upper part of the thoracic esophagus is a practicable surgical procedure, no attempt should be made to follow the resection by an intrathoracic esophago-esophagostomy. The operation should only be undertaken as a secondary step, following a preceding gastrostomy — the distal end of the thoracic portion being subsequently connected with the stomach, while the lower end is closed and left *in situ*. The esophagus is exposed through a right-sided flap, after disarticulating the right clavicle and excising parts of the first and second right ribs. The operation is transpleural — in the sense that it passes through both the anterior and posterior layers of the pleura of the right lung. Access is hereby also afforded to the superior upper part of the middle and posterior mediastina.

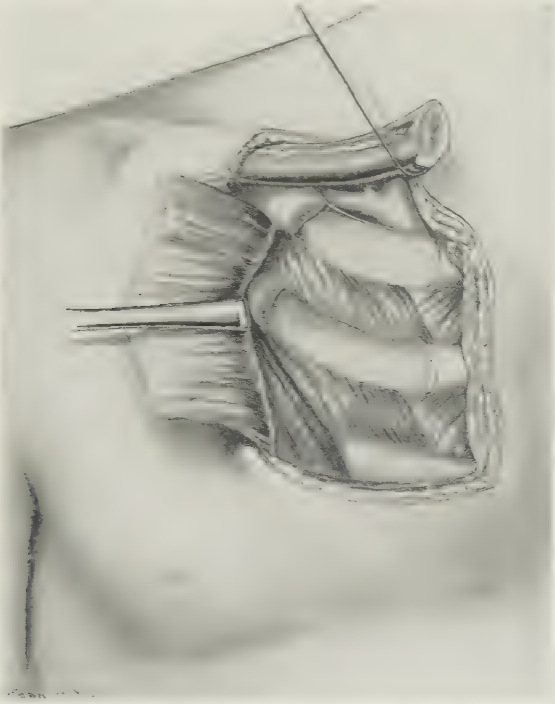


Fig. 3296.—Anterior Transpleural Exposure of the Upper Part of the Thoracic Esophagus (and Posterior Mediastinum) Through an Anterior Mediastinal Thoracoplasty — Sauerbruch's Operation — I; — The sternal end of the clavicle has been disarticulated and the clavicle drawn outward — and the costal cartilages of the first and second ribs excised — after turning back a flap of soft parts.

Preparation.—A Witzel gastrostomy is performed about fourteen days in advance.

Position.—As for other operations through the anterior thoracic wall.

Landmarks.—Right border of the manubrio-gladiolar portion of the sternum; right sternoclavicular joint; right first and second costal cartilages.

Incision.—The incision begins over the middle of the right clavicle — curves forward over the inner half of the clavicle, and downward over the right aspect of the sternum, near its middle _ to end opposite the lower border of the right third rib.

Operation.—At the designated time following the Witzel gastrostomy, and when all is in readiness, the operation for the partial excision of the esophagus is performed. Having made the incision just described, the flap of soft parts included within its bowed contour, including the pectoralis major, are raised *en masse* down to the clavicle, costal cartilages, and intercostal muscles, and retracted outward and downward. The cartilage of the right second rib, and, eventually, of the third rib, are subchondrially excised at about 3 cm. ($1\frac{3}{16}$ inch) from the sternum. The right clavicle is then either divided at the junction of its middle or inner thirds _ or dislocated outward, at its sternoclavicular end (Fig. 3296). The right first costal cartilage is then excised correspondingly with the others. Thus access is secured to the esophagus at the thoracic aperture, where the lower cervical esophagus trends to the right.

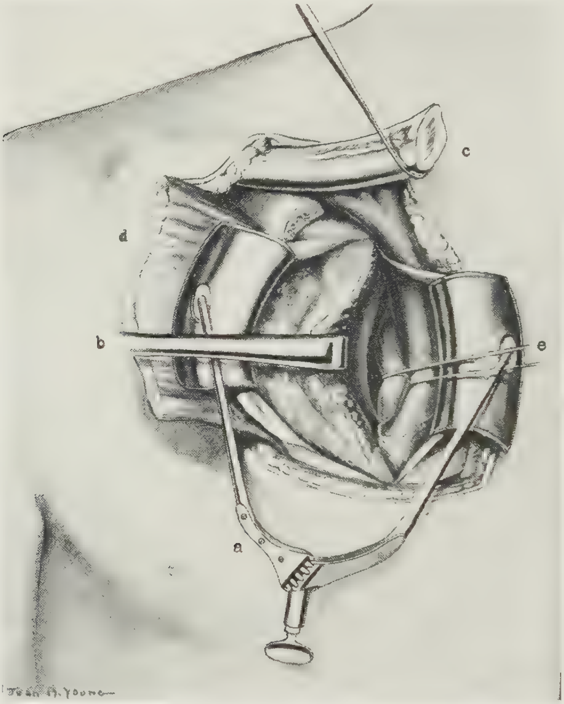


Fig. 3297.—The Same _ II: _ **a**, Sauerbruch's retractor, retracting the margins of the wound laterally; _ **b**, retracting the anterior margin of the right lung outward; _ **c**, the dislocated sternal end of the clavicle; _ **d**, overlying flap of thoracic-wall tissues; _ **e**, thoracic esophagus drawn forward, through the incised mediastinal pleura. (Figs. 3296–3297 redrawn from Sauerbruch.)

The plane of perichondrium and intercostal muscles is now carefully divided parallel with the sternal border _ and with the intrathoracic pressure lessened to about 3 mm. of Hg., the endothoracic fascia and parietal pleura are incised _ thus exposing the partially distended lung. Insert one blade of the rib-separator within, against the margin of the sternum _ and the other, without, against the cut costal stumps, and separate the blades _ as shown in Fig. 3297 _ so as to widen the wound of approach as far as possible.

With reduced differential pressure, the lung will tend to recede from its anterior and medial limits _ and is further retracted backward and outward by means of a special broad retractor. Thus space is secured, and room for manipulation, bounded by the lung pedicle, below _ by the mediastinum, mediad _ by the thoracic vault, above _ and by the retractor, without _ and with the structures of the region more or less discernible. The mediastinal pleura is now carefully seized between two forceps and cautiously incised _ after which a finger is introduced into this space and displaces the incised mediastinal pleura from the operative field. The following structures will then be demonstrable: _ the vena cava superior, with the phrenic nerve coursing over it lies forward, _ the trachea lies behind the vena cava, and more toward the median line, _ the innominate vein can be felt between the trachea and the vena cava, _ the right vagus nerve crosses a little above the vena azygos, in its course across the trachea to the right side of the esophagus, _ and behind the trachea lies the esophagus. The esophagus is made more readily recognizable by the passage of a sound from the mouth.

The esophagus is freed from its bed by blunt dissection, immobilizing the site of the growth _ the freeing being aided by the passage of a rubber tube as a temporary traction ligature around it. If the case be one of malignancy, the circumscription of the tumor and its mobilization are absolutely necessary to warrant further procedure.

Having mobilized the esophagus at the site of involvement, and the adjacent portion of the tube, above and below, a ligature is tied around the esophagus 1 or 2 cm. (7/16–13/16 inch) below the tumor _ the esophagus being clamped just below the tumor _ and, between these, the esophagus is divided with the actual cautery. The ligated and cauterized stump is then inverted within the lumen of the lower portion of the retained esophagus by means of forceps, after which the inverted stump is closed by buried and overlying sutures. A ligature is also thrown around the upper part of the esophagus, above the tumor, after which the tube is cut between the ligature and the tumor, which is then excised.

The upper end of the esophagus is then cautiously freed from its surroundings up as far as the thoracic opening. Guided by a finger introduced through the main wound into the superior mediastinum, a pathway into the neck is tunneled _ after which, by means of a loop of gauze carried through the wound in the neck, or by a pair of forceps, the free end of the divided esophagus is drawn out of the wound in the neck _ and, after the excess of length is excised, the remainder is carried through a slit in the sternocleidomastoid and anchored _ and provision made to establish communication between it and the stomach _ the patient being, in the meantime, fed through the gastric fistula.

POSTERIOR EXTRAPLEURAL EXPOSURE OF THE THORACIC ESOPHAGUS (AND POSTERIOR MEDIASTINUM) THROUGH A POSTERIOR MEDIASTINAL THORACOPLASTY

ENDERLEN'S OPERATION

Description.—A large flap of soft parts is raised from the right side, between spine and scapula, and turned backward over the spine _ and, after removal of the ribs, the posterior mediastinum is entered, extrapleurally, at considerable depth. The procedure is usually resorted to for the removal of foreign bodies which resist dislodgment through the esophagoscope; or for foreign bodies which have perforated the esophagus; for diverticula of the lower part of the esophagus; and for peri-esophageal suppuration. It is not an appropriate route in dealing with cancer of the esophagus _ for which the transpleural method is better

The operation bears certain similarities to Bryant's (Vol. III, p. 964) _ which Enderlen criticises upon three grounds, _ that the flap is too small, and, therefore, the approach too limited, _ that the temporary rib resection is an unnecessary complication, _ and that the extensive wound closing favors the retention of wound secretion.

Incision.—A right-angled flap is outlined, with its base at the spine, from the process of the third to that of the ninth thoracic vertebra _ the upper and lower incisions extending thence to the vertebral border of the scapula, where they are connected by a vertical incision.

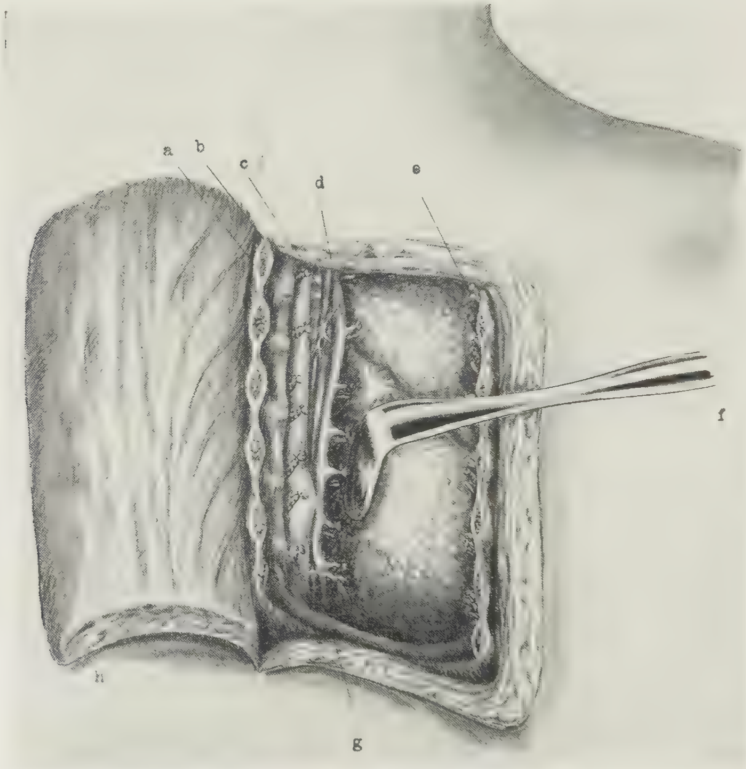


Fig. 3298.—Posterior Extrapleural Exposure of the Thoracic Esophagus _ and Posterior Mediastinum _ Through a Posterior Mediastinal Thoracoplasty Technic _ Enderlen's Operation: _ **h,** The thoracic flap of overlying soft parts, turned outward; _ **a, e,** sectioned ribs; _ **b,** vertebral column; _ **c,** trachea (in the upper part of the wound); _ **d,** intercostal vessels; _ **f,** outwardly retracted, pleura-covered lung; _ **g,** esophagus _ its position being indicated by the slight outward bulge of a sound passed through the pharynx.

Operation.—A solid flap of the full thickness of the soft parts overlying the ribs is cut through, down to the ribs and intercostal muscles, and is raised from the plane of the ribs and intercostal muscles and turned backward over the spine. The eighth rib is subperiosteally freed throughout an extent of about 10 cm. (4 inches) _ for the purpose of gaining access to the plane of the endothoracic fascia, and is the hardest part of the rib freeing. When once this rib has been subperiosteally removed, the rest of the progress is easier _ for, with a finger in the plane of the endothoracic fascia, advancing ahead to the rib next above, and beneath it, the pleura is pushed away and the rib is made accessible to safe division. The ribs above the eighth, up to the fourth, are removed extraperiosteally. It is generally possible to remove *en masse*, in at least two strips, the remaining ribs, with their intercostal muscles adherent — the intercostal vessels being tied at each end. In this connection Kuettner writes, "It is best to remove the flap made of ribs and intercostal musculature, since a reproduction (of the ribs), as carried out by Bryant, is a superfluous complication."

The pleura is cautiously freed toward the spine and ventralward (Fig. 3298). It is during this procedure that one makes progress carefully — both as to the pleura and the sympathetic nerve. When one has advanced sufficiently far toward the front of the spine, an esophageal sound should be introduced from the mouth and be made to cause the esophagus to bulge out into the field of operation — proceeding with care, of course, if the integrity of the esophagus be in doubt. As one advances it is necessary to be on the lookout for the vena azygos and for the thoracic duct. As one approaches the esophagus, the vagus plexus is encountered. The absolute preservation of all its small branches is an impossibility — and it is fortunate to avoid the more important branches. This is not to be wondered at, for, in adults, the operation will be at a depth of about 12 or 14 cm. ($4\frac{3}{4}$ or $5\frac{1}{2}$ inches) from the surface — and the difficulties of detailed manipulation are great. Extreme care should be exercised in isolating the esophagus — remembering that its wall is penetrated with great ease, even through to the mucosa.

It is generally possible to suture up a wound in the esophagus — or to repair the base of an excised diverticulum — or to provide for drainage in pus cases — but it is impracticable to satisfactorily perform a resection or a circular esophagorrhaphy through this approach.

The effort, throughout all manipulations, is to keep from invading the pleural cavity, but if the pleura be wounded, an attempt should be made to repair it.

At the close of the operation the thick soft flap is turned back into place and the wound closed by buried and superficial sutures. Drainage is established as indicated.

Comment.—It would seem that the patient would suffer practical inconvenience as a result of the non-subperiosteal removal of so much of so many ribs directly opposite the scapula and shoulder-joint.

CHAPTER LX

OTHER OPERATIONS UPON INTRATHORACIC STRUCTURES

Surgical anatomy of the thoracic portion of the trachea, p. 58; _ Transthoracic tracheotomy for foreign bodies, p. 58; _ Operative treatment of wounds of the thoracic portion of the trachea, or of the main bronchi, p. 58.

Surgical anatomy of the bronchi, p. 60.

Surgical anatomy of the thoracic portion of the thoracic duct, p. 60; wounds, p. 60

SURGICAL ANATOMY OF THE THORACIC PORTION OF THE TRACHEA

This has been given under Operations Upon the Cervical Portion of the Trachea, Vol. III, p. 598.

TRANSTHORACIC TRACHEOTOMY FOR FOREIGN BODIES

Such a procedure is rarely undertaken, especially since the introduction of tracheoscopic methods. Its chief indication would be foreign bodies _ which one would first endeavor to remove through peroral tracheoscopy _ next, through low tracheoscopy, or by forceps through a low tracheotomy wound. Failing in these, the bifurcation of the trachea could be exposed through a posterior mediastinal thoracoplastic flap _ and, in such an event, the operation then becomes similar, in all practical respects, with posterior transthoracic bronchotomy, which is described in Vol. III, p. 888. In dealing with the trachea the thoracoplastic flap may have to be planned a rib or two higher, as determined by the individual case, and especially by *x*-raying.

As the bronchi, immediately below the tracheal bifurcation, are more accessible by the posterior mediastinal route, because lower than the trachea itself, if there seems fair chance of being able to remove the foreign body from the trachea via one of the main bronchi, this may prove a simpler procedure.

It will be seen that the thoracic trachea is also exposed in the operation for the resection of the thoracic portion of the esophagus through an anterior mediastinal thoracoplastic operation _ which is described at p. 70.

OPERATIVE TREATMENT OF WOUNDS OF THE THORACIC PORTION OF THE TRACHEA OR OF THE MAIN BRONCHI

What has been said of the transthoracic treatment of foreign bodies applies also to wounds of the thoracic trachea _ in so far as methods of approach are concerned. In the case of wounds, however, their exact position cannot be predetermined by *x*-raying _ for even if a foreign body be revealed within the thorax, its position need not necessarily indicate the position of the tracheal wound. Its exact site, therefore, may not be known until the thorax has been opened.

The method of approach is usually through a posterior mediastinal thoracoplastic exposure, as described at Vol. III, p. 962, _ or even by an anterior mediastinal thoracoplastic exposure, Vol. III, p. 952.

An effort should be made to secure a satisfactory closure of the wounded trachea, when exposed. Tiegel's Lembert type of interrupted sutures constitute one of the best forms of tracheorrhaphy (Fig. 3299). Wherever this can be carried out, it is well to reinforce the sutured site of the trachea _ which Tiegel suggests may often be done by suturing a peripheral portion of adjacent lung tissue over the tracheal wound which has just been sutured _ which

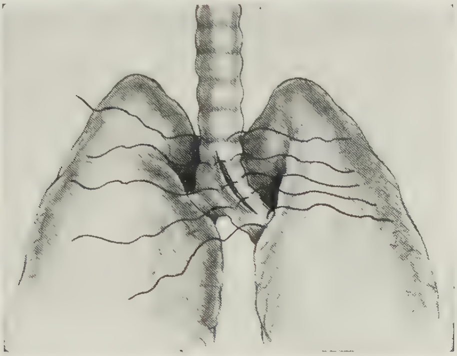
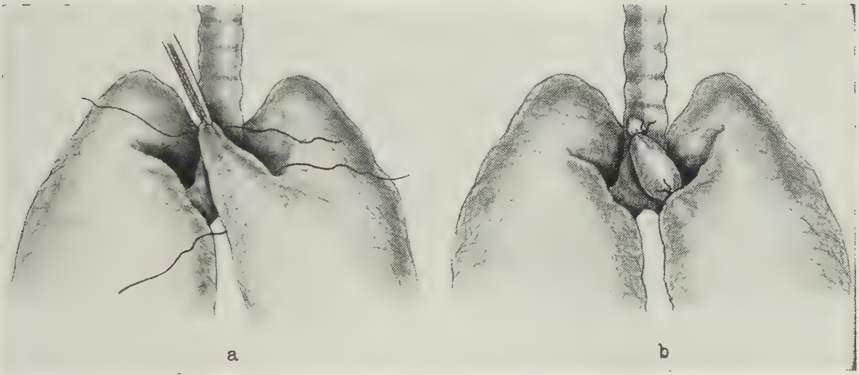


Fig. 3299.—TIEGEL'S METHOD OF CLOSING TRACHEAL AND BRONCHIAL WOUNDS — I; — Placing interrupted sutures, of the Lembert type, which, inverting the margins, approximate narrow strips of the outer surface of the tracheobronchial tube, without invading the lumen.



Figs. 3300 and 3301.—The Same — II and III: — **a**, Reinforcing the sutured site by the anchoring over it of a peripheral portion of the adjacent lung (as described in the text); — **b**, the completed tracheobronchorrhaphy reinforced.

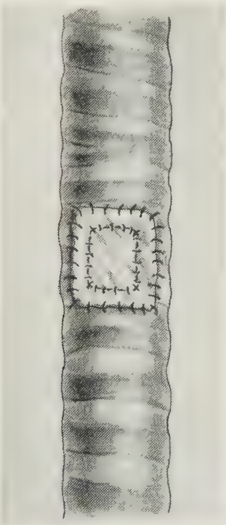


Fig. 3302.—HOHMEIER'S APONEUROTIC GRAFT APPLIED TO REINFORCE TRACHEAL AND BRONCHIAL SUTURING.

may generally be accomplished by using the free ends of the two stitches at the extreme ends of the tracheal wound after they have been knotted _ to tie down the border of lung upon the suture line _ as shown in Figs. 3300 and 3301.

If a peripheral portion of lung cannot be brought into convenient relation with the wounded trachea, the method of Hohmeier may be applied _ of taking a piece of the sternomastoid sheath _ or any other aponeurosis _ and anchoring it over the sutured wound _ as shown in Fig. 3302.

SURGICAL ANATOMY OF THE BRONCHI

Relations.—(1) **Right bronchus;** vena azygos major passes above bronchus from behind forward, on its way to superior vena cava; right pulmonary artery lies at first below and then in front of bronchus. (2) **Left bronchus;** passes beneath arch of aorta, resting upon esophagus, thoracic duct, and descending aorta; left pulmonary artery lies at first above and then in front of it.

Differences in the Bronchi.—(1) **Right bronchus;** about 2.5 cm. (about 1 inch) long; wider, shorter, and more horizontal than left; enters right lung opposite fifth dorsal vertebra. About 2 cm. (about $\frac{3}{4}$ inch) from origin the upper or eparterial branch of bronchus is given off above right pulmonary artery to upper lobe of lung; the main bronchus, or hyparterial branch, passes below and behind right pulmonary artery and divides into two branches, for middle and lower lobes. (2) **Left bronchus;** about 5 cm. (about 2 inches) long; smaller, longer, and more oblique than right; enters left lung opposite sixth dorsal vertebra about 2.5 cm., or 1 inch, lower than right). Left bronchus is entirely below left pulmonary artery (hyparterial), and divides into two branches, for upper and lower lobes. *Note.*—In majority of cases right bronchus seems a more direct continuation of trachea than left (that is, the dividing ridge between the two bronchi lies more to the left)—although the left is the more oblique in direction—wherefore, foreign bodies are more frequently lodged in the right bronchus.

Arteries.—Bronchial branches of thoracic aorta.

Veins.—Bronchial—emptying into vena azygos major on right side—and into superior intercostal vein on left.

SURGICAL ANATOMY OF THE THORACIC PORTION OF THE THORACIC DUCT

This has been given under Operations Upon the Lymphatic Glands and Vessels, Vol. II, p. 212 _ where has also been given the Suture and the Ligation of the Cervical Portion of the Thoracic Duct. The surgery of its abdominal portion will be considered in the section upon Abdominal Surgery.

OPERATIVE TREATMENT OF WOUNDS OF THE THORACIC PORTION OF THE THORACIC DUCT

Wounds and rupture of the thoracic portion of the thoracic duct are extremely rare _ owing to the unusually well-protected position of this portion of the duct.

Wounds of the thoracic portion of the duct are very likely to be associated with serious wounds of immediately adjacent important structures, especially of the large vessels in close relationship with which the duct lies.

Wounds of this portion of the duct may manifest themselves in a collection of chyle among the mediastinal tissues _ or by an accumulation of the fluid within the pleura (chylothorax). In addition, there may be the associated phenomena of inanition and rapid loss of body weight. (Where the main duct is replaced by a number of smaller vessels, individual wounds are of less consequence.)

Wounds of the duct are almost always accompanied by wounds of the pleura _ usually the right.

Cases of chylothorax are reported in which several liters of chyle are drawn away by pleural puncture at a time _ and from 20 to 30 liters in the entire course of the case _ the amount sometimes causing dyspnea.

Schwartz collected 13 cases of rupture of the thoracic portion of the thoracic duct _ with 6 deaths and 7 recoveries.

The course of action advised by Schwartz is the exposure of the wounded duct, through a posterior mediastinotomy, and the suture of the duct, upon the same principles that lymphatic and venous vessels are sutured.

The details of exposing the posterior mediastinum are found under Operations Upon the Mediastina (Vol. III, p. 962).

CHAPTER LXI

THORACIC OPERATIONS UPON THE DIAPHRAGM AND CONTIGUOUS STRUCTURES

Surgical Anatomy, p. 62; _ General surgical considerations in operating upon the diaphragm, p. 63.

Chondroplastic Resection of the Chest Wall for the Exposure of the Diaphragm and the Right or Left Hypochondriac Structures, by subcostal incision and temporary division of the seventh, eighth, ninth, and tenth costal cartilages, p 63; _ Transthoracico-transphrenic subpleural exposure of the liver by partial excision of two or three ribs, p. 64; _ Transthoracico-transphrenic, transpleural exposure of the liver by partial excision of two or three ribs, p. 67; _ Transthoracico-transphrenic, transpleural exposure of the liver by major intercostal thoracotomy, p. 68.

Transthoracico-transphrenic Resection of the Cardiac End of the Stomach, Followed by Intrathoracic Esophago-esophagostomy, By Major Intercostal Thoracotomy (Sauerbruch), p 70.

SURGICAL ANATOMY OF THE DIAPHRAGM

Attachments of Diaphragm.—**Anterior (sternal) part;** inferior and posterior border of the ensiform cartilage; neighboring posterior surface of the anterior aponeurosis of the transversalis muscle. **Lateral (costal) part;** inferior border and inferior surface of the cartilages and bony parts of the sixth or seventh inferior ribs. **Posterior (vertebral) part;** (*a*) ligamentum arcuatum externum (the thickened anterior layer of the lumbar fascia extending from the tip of the transverse process of the second lumbar vertebra to the tip of the twelfth rib); (*b*) ligamentum arcuatum internum (the thickened iliac fascia arching over the psoas, from the side of body of the second lumbar vertebra to the tip of the transverse process of the same vertebra). (*c*) right crus of the diaphragm (arising from the anterior surface of the bodies of the first to the third, or fourth, lumbar vertebra; from the intervening fibrocartilages; from the anterior common ligament); (*d*) left crus of the diaphragm (arising from the anterior surface of the bodies of the first to the second, or third, lumbar vertebra; from the intervening fibrocartilages; from the anterior common ligament). **The insertion** of these various origins is into the anterior, posterior, and lateral aspects of the central tendon of the diaphragm.

Structures in Relation with Diaphragm.—**Superiorly** (thoracic cavity); pleuræ and lungs; pericardium and heart. **Inferiorly** (abdominal cavity); peritoneum; liver; stomach; spleen; pancreas; kidneys; suprarenal capsules.

Upper Limits of the Diaphragm.—Right Leaflet, on a level with the junction of the fifth costal cartilage with the sternum (about 2.5 cm., or 1 inch, below the nipple). Left Leaflet, on level with the junction of the sixth costal cartilage with the sternum. Central Tendon, about on a level with the end of the sternum, or the seventh chondrosternal articulation.

Boundaries of Lower Thoracic Opening.—See Thoracic Wall, Vol. III, p. 774.

Structures Passing through Floor of Thorax (Diaphragm).—See Thoracic Wall, Vol. III, p. 774.

Other Relations of Diaphragm.—(*a*) The fibers of the diaphragm are absent or deficient in the interval between the sides of the muscular strip from ensiform cartilage to the cartilages of neighboring ribs—areolar tissue occupies this position, covered above by pleura, and below by peritoneum. (*b*) The central tendon of the diaphragm is blended with the pericardium.

(*c*) After forced expiration, the right diaphragmatic arch is on a level, anteriorly with the fourth costal cartilage; laterally, with the fifth, sixth, and seventh ribs; posteriorly, with the eighth rib; similar measurements on the left generally being from one to two ribs' width lower. In forced inspiration there is a descent of from 2.5 to 5 cm. (about 1 to 2 inches). (*d*) Circumferentially, the diaphragm is higher in the median line and lower at the sides _ but the central tendon supporting the heart is lower than the sides. (*e*) For a narrow interval around the lower and posterior circumference the diaphragm is not covered by pleura, but is in immediate contact with the chest wall. (*f*) The costophrenic sinus is that area over which the parietal and visceral layers of the pleura are in constant contact, whether in inspiration or expiration _ and is represented by the line of reflection of the diaphragmatic pleura on to the intrathoracic wall.

GENERAL SURGICAL CONSIDERATIONS IN OPERATING UPON THE DIAPHRAGM

Forming the boundary between the two greatest cavities of the body, the thoracic and abdominal, many of the operations upon, or in the immediate vicinity of diaphragm partake of some of the features peculiar to either thoracic or abdominal operarions _ and these features will sometimes dominate, in importance, the entire operation.

The majority of operations involving the diaphragm are primarily directed toward some structure adjacent to the diaphragm _ the diaphragm itself being involved only in so far as it may prove a barrier to reaching the goal of operation, with the necessity for its incision on the way to the object of operation.

CHONDROPLASTIC RESECTION OF THE CHEST WALL FOR THE EXPOSURE OF THE DIAPHRAGM AND THE RIGHT AND LEFT HYPOCHONDRIAC STRUCTURES

BY SUBCOSTAL INCISION AND TEMPORARY DIVISION OF SEVENTH, EIGHTH, NINTH, AND TENTH COSTAL CARTILAGES

Description.—Owing to the rigidity of the chest wall it is difficult to satisfactorily expose the dome of the diaphragm, the upper surface of the liver, the lower end of the esophagus, and the cardiac end of the stomach. By the temporary resection of the costal arch of either the left or right side, as indicated, these structures are much more readily brought into the operative field.

While this operation is generally resorted to in connection with structures within the abdominal cavity, yet as it involves the chest wall, it is here described among the thoracic operations.

Preparation.—As for an intra-abdominal operation.

Position.—The reversed Trendelenburg position causes the abdominal viscera to gravitate away from the dome of the diaphragm _ and hence renders the operation site more accessible.

Landmarks.—The costal arch of the side involved and the position of the seventh, eighth, ninth, and tenth ribs.

Incision.—In the case, for instance, of operating upon the upper surface of the liver, the incision is a curved one placed just below the right costal arch and extending from the ensiform cartilage to the tenth rib (Fig. 3303).

Operation.—In the upper aspect of this wound the rectus and external oblique muscles are separated from the internal oblique and transversalis _ thus exposing the lower margin of the costal arch, represented by the cartilages of the seventh, eighth, ninth, and tenth costal cartilages. The cartilage of the seventh rib is divided near its junction with the sternum. Carrying the blunt dissection downward and outward, the junction of the seventh, eighth, ninth, and tenth ribs with their cartilages are exposed _ and the cartilages divided just internal to their junctions with the corresponding ribs (Fig. 3303, the darkened area). The flap thus composed of these cartilages and their overlying soft parts is retracted upward and outward _ giving free access to the hypochondrium. At the end of the operation the cartilages are dropped back into place _ where their divided ends may be sutured with catgut through holes previously pierced _ and the wound sutured.

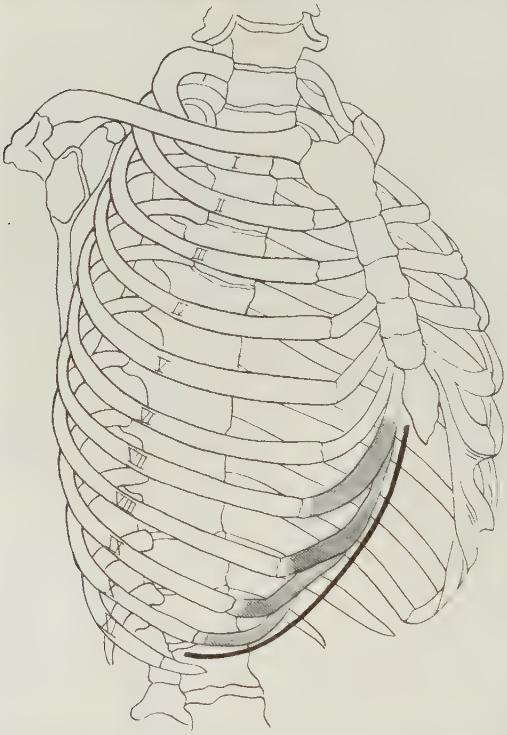


Fig. 3303.—Chrondoplastic Resection of Chest Wall; _ Subcostal incision of soft parts seen just below costal arch, from ensiform cartilage to tenth rib. Costal cartilages of seventh, eighth, ninth, and tenth ribs are divided at each end of darkened part _ which latter represents the portion of costal arch temporarily turned back. (Thorax modified from Bock.)

TRANSTHORACICO-TRANSPHRENIC SUBPLEURAL EXPOSURE OF THE LIVER

BY PARTIAL EXCISION OF TWO OR THREE RIBS

Description.—The upper (thoracic) surface of the diaphragm is exposed (at the site of the diaphragmatic lesion) by means of the partial excision of two or three ribs performed subperiosteally, through a single incision between them. Or the site may be exposed by turning back a flap of overlying soft parts and then excising the indicated parts of the ribs, _ or an osteo-thoracoplastic flap may be temporarily turned aside and replaced at the end of the operation. (See Operations Upon the Pleura and Heart.) Having opened the chest wall over the area, the diaphragm may be approached in one of several ways _ below the reflection of the pleura, _ subpleurally (after detaching and pressing back the unopened pleura), _ transpleurally (the pleuræ being nonadherent), _ or through adherent pleural surfaces. Indicated for the evacuation of pus in subphrenic abscess; for the repair of wounds of the diaphragm; for hernia through the diaphragm. In subphrenic abscess the approach is usually made by the lumbar, iliac, or lateral thoracic routes, in order of preference _ parts of the ninth and tenth ribs being excised in simple subphrenic abscess _ and part of the eighth if the pleura be involved. The site of the operation may be on either side and will be determined by the lesion and the physical signs. Generally from 7.5 to 10 cm. (about 3 to 4 inches) of the ninth and tenth ribs, between the anterior axillary and scapular lines, as indicated, are excised through a single incision made between them, in the case of an abscess between the liver and diaphragm, which is usually approached subpleurally. Where the abscess is near the dome of the diaphragm, the transpleural approach at a higher level generally must be used. The excision of one or more costal cartilages in the mammary line may suffice.

For operations for hepatic abscess and empyema see Operations Upon the Liver and Pleura.

Position.—Determined by the lesion _ and will be such as to conveniently expose the area _ in this case in the semiprone position.

Landmarks.—Site of lesion; line of pleura; line of diaphragm.

Incision.—In the center of the interspace between the ninth and tenth ribs _ the center of the incision being midway between the anterior axillary and scapular lines _ and about 13 cm. (about 5 inches) in length, so as to provide for the removal of about 9 cm. (about $3\frac{1}{2}$ inches) of each rib.

Operation.—Incise through skin, fascia, and overlying thoracic muscles, down to the plane of intercostal muscles, clamping all bleeding vessels. Free back the upper and lower lips of the wound upon this same plane, until the ninth and tenth ribs are reached and exposed in their entire width _ the soft parts being retracted well above and below their limits. Subperiosteally excise about 9 cm. (about $3\frac{1}{2}$ inches) of each rib, in the usual manner (see the Subperiosteal Excision of the Ribs, Vol. I, p. 754) _ carefully guarding the parietal pleura from the slightest nicking or injury (Fig. 3304). Incise the intercostal tissues longitudinally in the center of the interspace between the two excised ribs. If necessary, the intercostal arteries of the excised ribs may be ligated at both ends, though this may be omitted generally, as they are usually not in the way unless it be indicated to carry an incision across their course. Preserve the intercostal nerves by retraction. The removal of these two ribs generally gives ample room for exposure when the upper and lower limits of the wound are well retracted.

Five methods of reaching the diaphragm are now open to the operator: (*a*) If the site of operation be below the level of the reflected pleura, where the diaphragm and chest wall are in contact, the diaphragm may be approached at once, _ (*b*) If the pleura be encountered as soon as the chest cavity is opened, its parietal layer should be most carefully detached with the fingers and by means of blunt dissection and peeled back from its connection with the endothoracic fascia and surface of the diaphragm _ peeling it backward with the tips of the fingers and constantly pushing it from the freed area with the back of the fingers _ continue this freeing back of the unopened pleura until the site of the diaphragmatic operation is reached _ and then hold the pleura in place by gauze packing (Fig. 3304). (*c*) If both surfaces of the pleura are found adherent, thus shutting off the general pleural cavity, the incision may be carried directly down to the diaphragmatic site without danger of entering the pleural cavity (unless the adhesions be pulled apart in the manipulations), — (*d*) If the two pleural surfaces are not adherent, and it be impracticable to detach the pleura as described under (*b*), the two pleuræ may be united by suture around an area sufficiently large to admit of operating within and thus reaching the diaphragm at once. (*e*) If the two pleural layers be found not in contact by adhesion, and cannot be separated and displaced upward as mentioned under (*b*), and if time be to spare, adhesion between the two surfaces may be brought about by gauze packing, with the accomplishment of the rest of the operation two or three days later, when the cavity will have been closed off by adhesions. Where it is possible to choose the route, it is better to approach the diaphragm either below the level of the pleural reflection — or to detach the unopened pleura and reach the diaphragm beneath the pleural cavity.

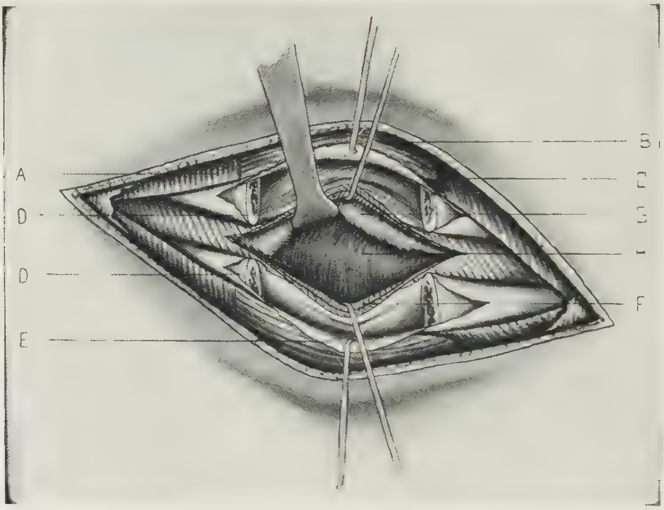


Fig. 3304.—Transthoracic Subpleural Exposure of Diaphragm Through the Right Ninth Intercostal Space: — A, Latissimus dorsi muscle; B, Serratus magnus muscle; C, Obliquus externus abdominis muscle; D, D, Resected ends of ninth and tenth ribs, the periosteal bed extending between the exposed ends, the intercostal vessels and nerves showing through the periosteum; E, Anterior layer of periosteum retracted and everted; F, Posterior layer of periosteum, together with external and internal intercostal muscles, retracted; G, Pleura displaced upward; H, Diaphragm.

The surface of the diaphragm having been exposed, the special object of the operation is now accomplished — the abscess incised — the wounded diaphragm sutured — or the hernial opening closed — upon the same principles practised elsewhere. Owing to the constant movement of the diaphragm, it is somewhat more difficult to deal with its structure. An abscess cavity should be evacuated by the most direct route, especially guarding the pleural cavity from infection. If a newly made wound exist, it is sutured at once. If the wound be old, or the opening be a hernia, the edges are seized with toothed forceps to steady them and then freshened with curved blunt scissors — the moving lung being held out of the way, if necessary, by gauze packing — and with a fully curved needle, held in special needle-holder, the margins of the wound or opening are brought together with chromic gut sutures.

The pleural sac, previously held out of the way by packing, is now allowed to fall into place. Temporary drainage is established, if indicated, through an unsutured part of the external wound _ the remaining portion of the outer wound being closed.

Comment.—(*a*) If the pleura be nicked, ligate or suture it at once. (*b*) If necessary to gain more room, free back the soft parts and excise the same amount of the rib above or below _ especially is this the case when it is needed to reach the diaphragm nearer its dome. (*c*) A U-shaped flap, with base forward or backward, may be used to expose the ribs. (*d*) On the left side all calculations are made somewhat lower.

TRANSTHORACICO-TRANSPHRENIC, TRANSPLEURAL EXPOSURE OF THE LIVER

BY PARTIAL EXCISION OF TWO OR THREE RIBS

Description.—Under these circumstances, from one to three ribs, usually, are excised subperiosteally, at some point above the lower level of reflection of the pleura, over a distance of about 10 cm. (4 inches) _ and, through the bed thus exposed an incision is made down to the parietal pleura, which, if not adherent, is surrounded by a tier of sutures sufficiently extensive to include the area to be incised _ after which both layers of the pleura are incised _ as well as the liver substance beyond. The operation is usually performed for hepatic abscess.

Preparation.—As for thoracotomy, in general.

Position.—The patient lies with the right side presented prominently to the Surgeon.

Landmarks.—These will depend upon the position of the incision _ which, in turn, is often determined by a preceding exploratory puncture.

Analgesia is usually employed.

Incision.—The incision is largely determined by the diagnosed position of the pus accumulation, as nearly as this is possible _ and, while exploratory puncture through unadherent pleura, for supposed pus in a structure beyond, is, strictly, hardly justifiable surgery, this course, nevertheless, is the one usually followed _ and the location of the incision then determined. As a rule, the incision is generally made with its center in the anterior axillary line, between the right seventh and eighth ribs _ or with its center in the posterior axillary line, between the right eighth and ninth ribs. The incision is usually from 8 to 10 cm. ($3\frac{2}{16}$–4 inches) in length.

Operation.—The incision is deepened through skin, fascia, and latissimus dorsi and external oblique, in the midcostal space, until the plane of the intercostal muscles is reached _ when the soft parts, partly by blunt dissection and partly by retraction, are drawn upward and downward, until the rib above, and the rib below, are exposed _ after which parts of these, corresponding with the wound, are excised subperiosteally. The intercostal vessels may be ligated, along with the intercostal soft parts, *en masse*, and the intervening parts cut away _ as shown in Fig. 3305. Or the vessels may be ligated at each end of the wound _ the intercostal nerve being preserved _ after which the bed of intercostal muscles may be slit in their middle, parallel with the intercostal space _ and retracted upward and downward. The latter course is preferable.

If the pleura be definitely known to be adherent, one may proceed to cut directly into the liver abscess. If it be non-adherent, and time for the formation of adhesions through packing be non-available, one then carries an oval line of continuous suturing around the area to be incised, uniting periosteal rib-bed, endothoracic fascia and parietal pleura, on the one hand, to the diaphragmatic pleura and diaphragm, on the other. An incision is then made, within this space, through the pleura, and carefully through the diaphragm — but, at this stage, no further. Examination should now be made — and if the peritoneum is found adherent to the upper surface of the liver, one may proceed at once to incise the liver — but, if the peritoneum and liver be non-adherent, another tier of oval sutures must be introduced between the parietal and visceral layers of peritoneum. Finally, the liver (after being again explored, if necessary) is incised — the pus cavity drained and examined with the finger (which breaks up secondary cavities if these exist) into the main one — after which it is packed with gauze, which is brought out through the thoracic wound.

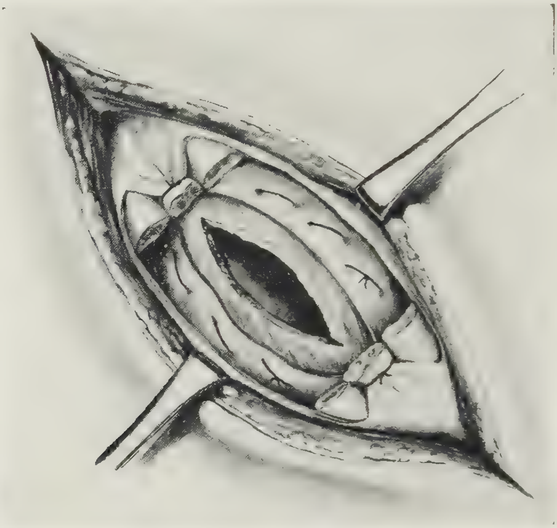


Fig. 3305.—Trans-pleuro-trans-diaphragmatic Exposure of the Upper Aspect of the Liver — Through the Partial Excision of Two Ribs — Kocher's Technic; — The intercostal tissues are here shown ligated. The parietal pleura is sutured to the diaphragm, which has been incised, exposing the liver.

TRANSTHORACICO-TRANSPHRENIC, TRANSPLEURAL EXPOSURE OF THE LIVER

BY MAJOR INTERCOSTAL THORACOTOMY

Description.—This technic is described, by Sauerbruch, as being especially useful in cases where the liver or spleen is wounded through the thoracic wall — as the simultaneous exposure of both thoracic and abdominal cavities is thereby quickly and easily made. The exposure is accomplished by major intercostal thoracotomy.

Incision.—This was made, in one of Sauerbruch's cases, in the right sixth intercostal space — where a bullet had entered, penetrating the chest, diaphragm, and wounding the liver.

Operation.—The intercostal thoracotomy is accomplished in the usual manner (Vol. III, p. 822). Upon the completion of the incision and drawing apart the blades of the separator, in the case in question, marked pneumothorax and hemorrhage were found within the thorax, and the middle and lower lobes of the lung were wounded — the blood coming, in small part from the lung wounds, and in large part from the wounded pericardiacophrenic artery.

The diaphragm showed a lacerated wound _ and a hematoma protruded from the upper surface of the liver. The lung-wounds were sutured and the spouting artery tied. The diaphragm was incised obliquely to its fibers _ exposing the right hypochondrium (Fig. 3306). The dome of the liver, in the neighborhood of the vena cava, was destroyed _ and there was blood in the peritoneal cavity. Destroyed liver tissue was removed, and the wound tamponed _ the gauze of the tamponade being brought out through a small incision made in the abdominal wall, near the umbilicus. The diaphragmatic wound was closed by suture _ the lung distended _ and the thoracic wound closed air-tight.

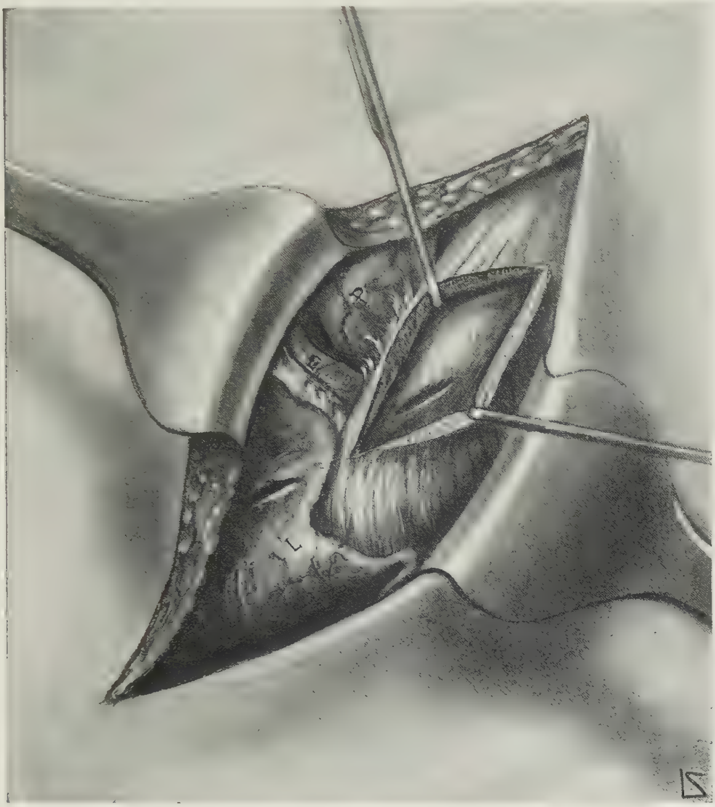


Fig. 3306.—Transpleural, Transphrenic Exposure of the Liver _ By Major Intercostal Thoracotomy; _ Major intercostal thoracotomy has been here performed in the right sixth intercostal space for a stab-wound piercing the right lung, diaphragm, and liver _ and the sixth and seventh ribs forcibly drawn apart; _ The wound in the diaphragm has been enlarged _ and the wound in the liver exposed; _ The wound in the lung, L, is seen. Mediad from the thoracic wound are seen the pericardium, P _ the esophagus, E.

Comment.—Incising the diaphragm is followed by no complication.

Sauerbruch states that the removal of the spleen by the transthoracic route is simpler and easier than by the abdominal route.

TRANSTHORACIC, TRANSPHRENIC RESECTION OF THE CARDIAC END OF THE STOMACH, FOLLOWED BY INTRATHORACIC ESOPHAGO-GASTROSTOMY

BY MAJOR INTERCOSTAL THORACOTOMY _ SAUERBRUCH'S OPERATION

Description.—The lower portion of the thoracic cavity is exposed, upon the left, by a major intercostal thoracotomy _ after which the lower portion of the esophagus is mobilized _ the dome of the diaphragm is incised, up to the esophagus, and the cardiac end of the stomach drawn through into the thoracic cavity. An anastomosis-button, of the Payr-type, carried through the mouth, is tied in the esophagus, just above the cardia _ after which the esophagus is severed below the button _ and the cardia is divided to the pyloric side of the growth. The open cardiac end of the stomach is then doubly sutured _ and the lower end of the esophagus, with the tied-in button, is invaginated through a slit made into the stomach, through its fundus _ after which the stomach is tied around the invaginated button-armed end of the esophagus, by two tiers of invaginated, purse-string sutures. The diaphragm is then sutured around the cardia _ and the thoracic cavity closed.

Preparation.—The range of the operation is unusually great, invading, as it does, two cavities, the thoracic and the abdominal, and opening up the intervening muscular partition _ the local and constitutional preparations for a combined intrathoracic and intraperitoneal operation, with an opening in the alimentary tract must, therefore, be unusually thorough. An esophageal sound is introduced before anesthesia is commenced _ to be used later in the operation in the manipulations.

Position.—The patient lies in a dorsolateral posture, with the left side rendered prominent.

Landmarks.—The left seventh intercostal space.

Anesthesia.—General anesthesia is employed.

Incision.—An incision of at first about 15 cm. ($5\frac{14}{16}$ inches) is made in the left seventh intercostal space _ which may be extended from the anterior end of the space, as far backward as necessary, with the progress and needs of the extensive operation.

Operation.—Having opened up the thoracic cavity, the hand is introduced and the cardiac aspect of the stomach examined through the diaphragm, as to its operability _ and, if operation be found indicated, the rib-separators are introduced, and the wound widened. While the differential pressure is reduced to 3 mm. Hg., the lower lobe of the lung is retracted upward and backward _ exposing the dome of the diaphragm and the mediastinum (Fig. 3307). If adhesions bind the lower part of the lung and the diaphragm, these are severed by blunt dissection.

The Surgeon now grasps the tendinous portion of the diaphragm with forceps and draws it outward, and incises it obliquely to the direction of its fibers _ and then enlarges the opening through the diaphragm up to the esophageal hiatus. The pleural reflection over the lower part of the esophagus is split, aided by the previously introduced sound _ cautiously freeing and safeguarding the vagus branches to the esophagus. The stomach is then drawn through the diaphragmatic opening, and handed over to an Assistant. When the cardia has been delivered, a rubber tube is conducted around the lower part of the esophagus _ and is used as a tractor in the further process of freeing the structures (which is easy anteriorly, but difficult toward the median and lateral aspects). While the dome of the cardia and the esophagus are being drawn upward and outward, the anchorage, by suture, of the base of the cardia drawn through the diaphragmatic opening, to the margin of that opening, is accomplished _ thus making the subsequent manipulations easier, especially the later division of the median portion of the esophagus. In carrying out this maneuver it is easy to doubly ligate the adjacent small vascular plexus and divide it. The act also aids in the isolation and ligating of the left gastric artery.

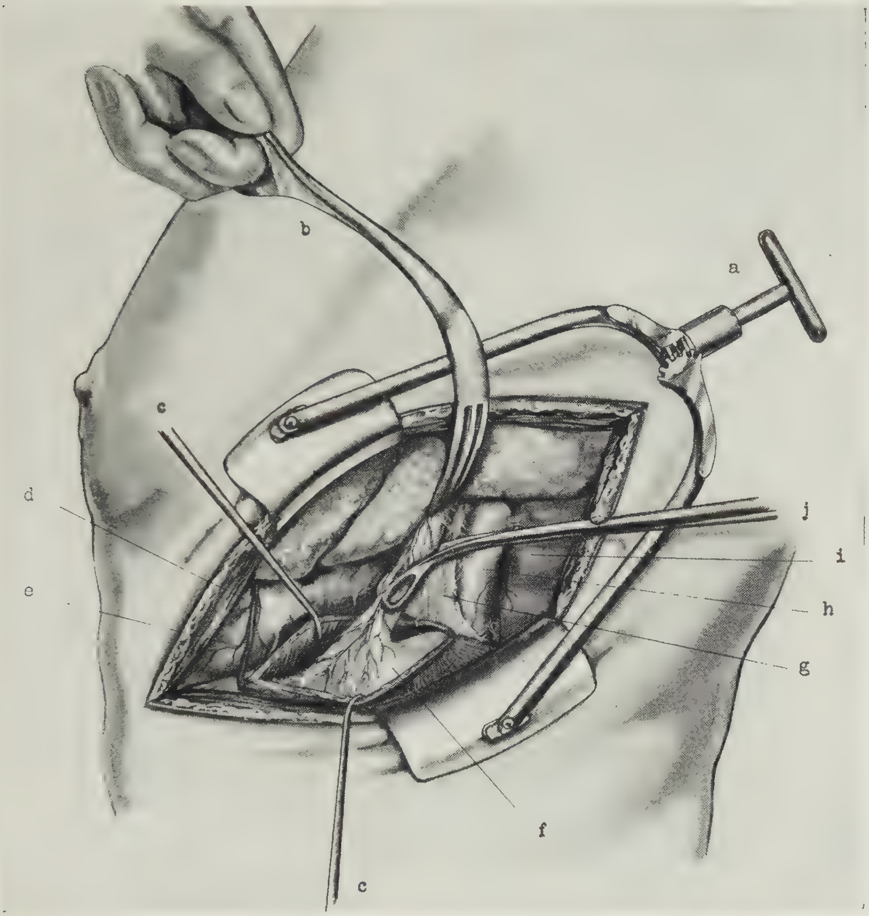
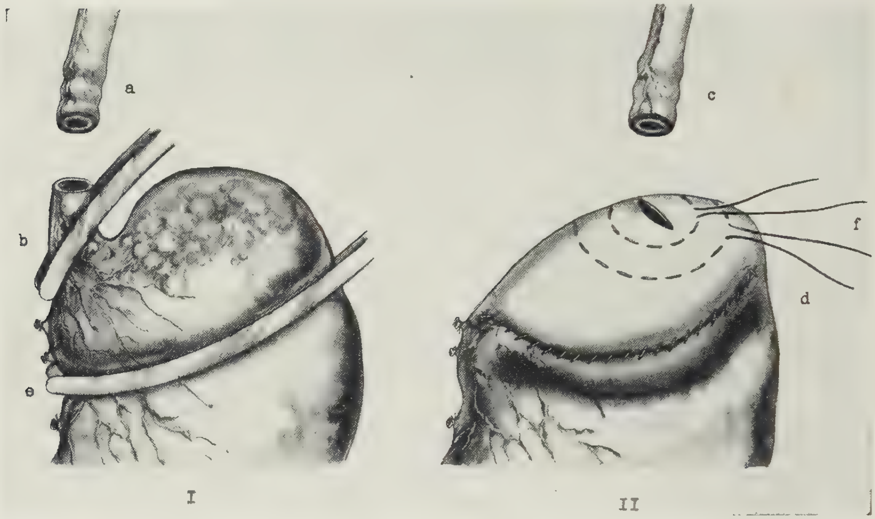


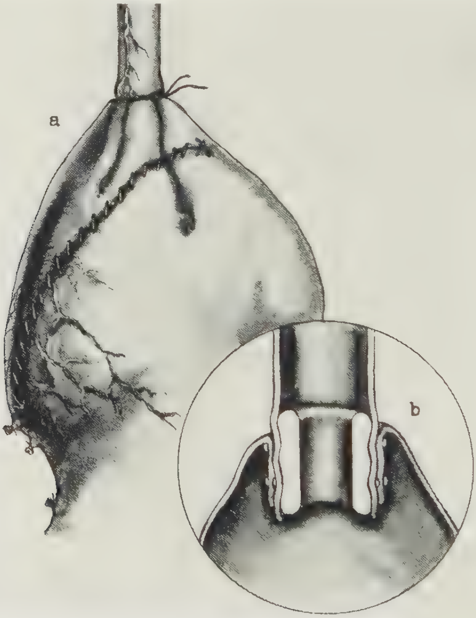
Fig. 3307.—Transthoracic, Transphrenic Resection of the Cardiac End of the Stomach, Followed by Intrathoracic Esophagogastrostomy _ By Major Intercostal Thoracotomy _ Sauerbruch's Operation _ I: _ **a**, The ribs bounding the left seventh intercostal space are forcibly drawn apart by Sauerbruch's rib-retractor; _ **b**, upward retraction of the lower aspect of the left lung; _ **c**, **c**, retractors of the incised diaphragm; _ **d**, pericardium; _ **e**, phrenic nerve and pericardiophrenic vessels; _ **f**, cardiac end of stomach, seen through the diaphragmatic opening; _ **g**, pulmonary ligament; _ **h**, descending aorta2 _ **i**, vetrebræ; _ **j**, esophagus, upon which traction is being made upon the stomach. (Figs. 3307–331; modified from Sauerbruch.)

The freeing and delivery of the stomach through the diaphragm makes it possible to also free the esophagus from its bed for a further distance up. This is accomplished by drawing upon the gastric portion of the esophagus, and thus stretching the connective-tissue attachments of the mediastinal portion of the esophagus _ which is largely accomplished by blunt dissection with gauze. The vagus nerve is sometimes injured in this separation of the esophagus _



Figs. 3308 and 3309.—The Same _ II and III; _ II, Excision of the esophago-cardiac segment: _ **a,** Divided esophagus; _ **b,** clamped gastric end of esophagus; _ **e,** line of stomach clamped between the cardiac and pyloric ends.

III, Anastomosis of the esophagus with the stomach: _ **c,** Divided esophagus; _ **d,** the sutured aspect of the stomach has been displaced forward, so that the posterior aspect of the remainder of the cardiac end of the stomach is brought into the field; _ **f,** double tier of purse-string sutures surrounding the incised site of esophageal implantation.



Figs. 3310 and 3311.—The Same _ V and VI; _ The completed esophagogastrostomy: _ **a,** The lines of union; _ **b,** sectional view of the anastomosis, accomplished with the Payr button.

and it is often impossible to avoid it when it is bound up with the tumor. The pneumogastric nerves are then easily cut through. The intentional cutting of the pneumogastric is less dangerous than injuring it by crushing or ligation. In the division of the lower part of both vagi in experimental research upon animals, and in several cases where it has happened in man, no detectable disturbance followed. The freeing of the stomach, tumor, and esophagus constitute the first stage of the operation.

A very considerable part of the problem from now on concerns the avoidance of infection of the pleura. To avoid such infection Kuettner and Schmieden advise operation in two stages _ isolating the tumor and tamponing its neighborhood with gauze at this stage _ and, from eight to fourteen days after completing the operation _ one then being able to continue the operation extrapleurally.

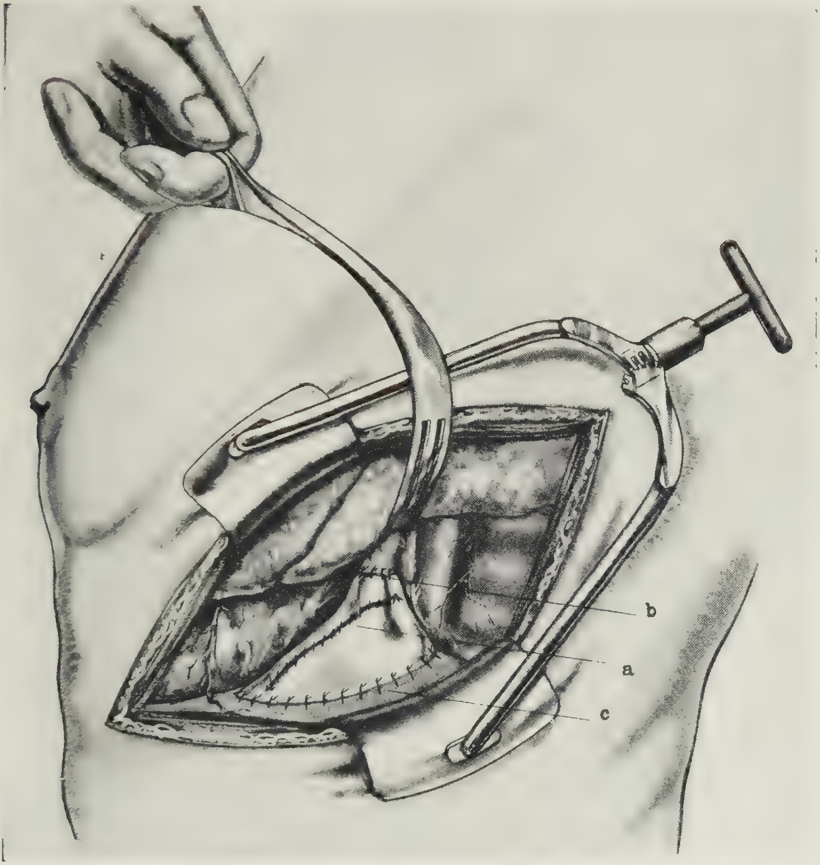


Fig. 3312.—The Same _ II; _ The union of esophagus and stomach accomplished: _ **a**, Sutured line resulting from excision of the cardiac end of the stomach; _ **b**, sutured line of the esophago-gastrostomy junction; _ **c**, sutured margin of the diaphragmatic opening, to the base of the remainder of the cardiac end of the stomach, drawn through the opening in the diaphragm.

In those cases in which the completion of the operation is brought about at one séance, Sauerbruch adopts a button-method of gastro-esophagostomy (instead of simple suture, as sometimes used), using either a Payr or a Tiegel button (Figs. 3308 and 3309). The technic will be here given with the Payr button _ which is a single button, or short tube, with two circularly running grooves, with a ridge above and below, and one between them. The Payr button is introduced through the mouth and passed on down to a reasonable distance above the tumor, when the esophagus is circularly tied around the lower groove upon the button _ after which the esophagus is divided below the button, and immediately protected with gauze. The cardiac portion of the clamped stomach involved by the tumor is then excised _ after which the free edges of the remaining sound portion of the stomach are united by a double tier of sutures (Figs. 3310 and 3311). An incision is then made into the fundus of the stomach (somewhat toward its posterior aspect) _ and this opening is guarded by two purse-string sutures. The free end of the esophagus, with the button tied into it, around its lower groove, is carried into the stomach _ and the upper purse-string is tied around the same (lower groove) _ after which the esophagus is further invaginated, and the second purse-string suture tied around the upper groove.

The diaphragm is sutured around the base of that portion of the stomach projecting above it _ the part above the diaphragm thereafter remaining within the thoracic cavity (Fig. 3312). It is of extreme importance to calculate that a sufficient excess of stomach lies above the sutured line to do away with the possibility of having the diaphragm tense the intrathoracic portion of the stomach, in the downward phases of its excursions _ which, of course, would tend to tear away the stomach from the esophagus or cause a leakage.

After the accurate suturing of the diaphragm around the stomach the lungs are again inflated _ and the thoracic cavity entirely closed.

Comment.—The pleura is divided over the esophagus _ and care is exercised in freeing by blunt, gauze dissection, the vagi and the vessels from the esophagus. In the method of union by invagination, the muscular wall of the esophagus is brought into contact with the serous and muscular coats of the stomach.

CHAPTER LXII

OPERATIONS UPON THE ABDOMINOPELVIC WALL

Surgical Anatomy of the Abdominopelvic Wall, p. 75; _ Surface form and landmarks of the abdominopelvic wall, p. 81; _ General surgical considerations in operations upon the abdominopelvic wall and cavity, p. 83.

Operative Treatment of Wounds of the Abdominopelvic Wall, p. 86; _ Operations for the removal of tumors of the abdominopelvic wall, p. 86; _ Tumors involving the surface and superficial layers of the abdominopelvic wall, p. 86; _ Tumors involving the full thickness of the abdominopelvic wall, p. 87; _ Operative treatment of abscesses of the abdominopelvic wall, p. 87; _ Excision of the umbilicus, for tumor (umbilectomy), p 87; _ Superficial excision of the umbilicus, p. 87; _ Excision of the umbilicus, involving the full thickness of the abdominal wall, p. 87; _ Operation for excess of fatty abdominopelvic wall (abdominopelvic lipectomy), p. 88; _ Herniæ of the abdominopelvic wall, p. 91; _ Plastic repair of the abdominopelvic wall, p. 91

Operations for the Exposure of the Abdominopelvic Cavity, in General, p. 91; _ Median abdominal section by the ordinary method, p. 91; _ Closure of abdominal section by the overlap method, and by the Reverdin needle technic, p. 111; _ Anterolateral abdominal section by McBurney's intramuscular ("gridiron") incision, p 121; _ Anterolateral abdominal section by the Harrington-Weir prolongation of the anterolateral intramuscular incision through the rectal sheath, with temporary displacement of the rectus, p. 125; _ Anterior abdominal section through a vertical incision in the outer part of the rectal sheath, with temporary inward displacement of the rectus, by the Battle method, p. 127; _ Anterior abdominal section, through a vertical paramedian incision in the inner part of the rectal sheath with temporary outward displacement of the rectus (Lennander), p. 130; _ Median inferior abdominal section by Pfannenstiel's superficial transversely curved and deep vertical incisions, p. 131; _ Inferior anterolateral abdominal section by Meyer's "hockey-stick" incision, p. 132; _ Inferior anterolateral abdominal section by Fowler's angular incision, p. 133; _ Superior anterolateral abdominal section by oblique subcostal incision, p. 135; _ Exposure of hypochondriac regions by chondroplastic resection of chest wall by subcostal incision, and temporary division of the seventh, eighth, ninth, and tenth costal cartilages, p. 136; _ Lateral abdominal section by Vischer's lumboiliac incision, p 136.

SURGICAL ANATOMY OF THE ABDOMINOPELVIC WALL

Boundaries of the Abdominopelvic Cavity.—Above; concave dome of diaphragm. **Below;** levatores ani and coccygei muscles ("diaphragm of pelvis"). **Laterally;** lower thoracic and abdominal and pelvic walls.

Boundaries of Abdominal Cavity.—Superiorly; central tendon of diaphragm (rising to about inferior end of sternum, or seventh chondrosternal joint); right half of diaphragm (to about level of fifth rib, or about 2.5 cm., or 1 inch, below right male nipple); left half of diaphragm (rising not quite so high as right); costal arches and ensiform process of sternum. **Inferiorly;** ileopectineal lines, laterally; crest of pubic bones, anteriorly; base of sacrum and sacrovertebral angle, posteriorly; Poupart's ligaments, superficially.

Boundaries of Pelvic Cavity.—Superiorly; ileopectineal lines, laterally; crest of pubic bones, anteriorly; base of sacrum and sacrovertebral angle, posteriorly. **Inferiorly;** Anteriorly; pubic arch and subpubic ligament; rami of os pubis and ischium; _ Posteriorly; great sacrosciatic ligaments and tip of coccyx; _ Laterally; tuberosities of ischia.

Regions of the Abdominopelvic Cavity and Their Contents.—Bases of divisions; Two horizontal lines are drawn _ one corresponding with the lowest part of the tenth costal arch _ the other with the most prominent lateral points of the iliac crests; _ and two vertical lines are made to intersect these, passing upward from the center of Poupart's ligaments _ thus forming the nine following regions (Quain): _ **Epigastric;** most or all of left lobe of liver; part of right lobe of liver; gall-bladder; part of body and cardiac and pyloric

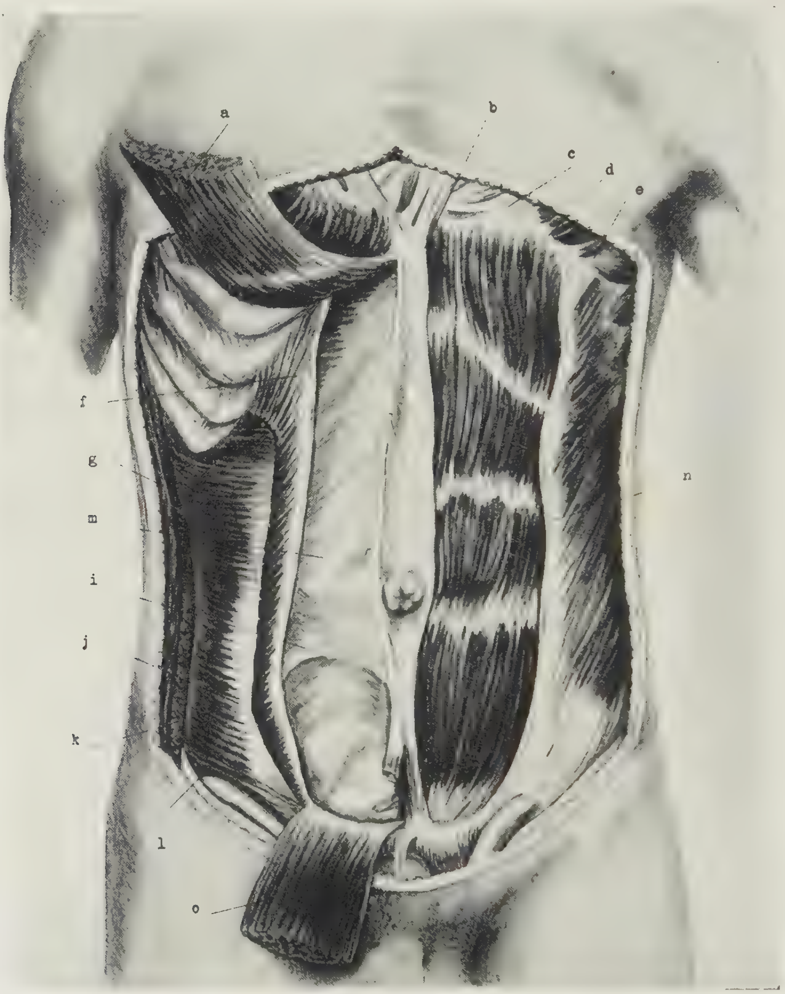


Fig. 3313.—The Musculo-aponeurotic Structures of the Anterior Abdominal Wall: _ **a, o,** Divided right rectus, turned outward; _ **b,** inner margin of the left rectal sheath; _ **c,** interdigitation of the pectoralis major and upper end of the left rectus; _ **d,** left rectus; _ **e,** external oblique; _ **n,** outer margin of left rectal sheath; _ **f, l,** internal oblique; _ **g,** sectioned external rectus; _ **m,** posterior layer of the rectal sheath, from which the divided ends of the right rectus have been turned upward and downward; _ **i,** linea semicircularis, at which level the transversalis passes entirely in front of the rectus; _ **j,** transversalis; _ **k,** sectioned internal oblique. (Modified from various Anatomies.)

orifices of stomach; first and second parts of duodenum; duodenojejunal flexure; pancreas; supero-internal part of spleen; parts of both kidneys; suprarenal bodies. **Right hypochondriac;** most of right lobe of liver; hepatic flexure of colon; part of right kidney. **Left hypochondriac;** portion of stomach; greater part of spleen; tail of pancreas; splenic flexure of colon;

part of left kidney; part of left lobe of liver (sometimes). **Umbilical;** most of transverse colon; third part of duodenum; some convolutions of jejunum and ileum; part of mesentery; part of great omentum; part of right kidney (sometimes parts of both). **Right lumbar;** ascending colon; portion of right kidney; part of ileum (sometimes). **Left lumbar;** descending colon; part of jejunum; small part of left kidney (sometimes). **Hypogastric;** convolutions of ileum; bladder in children (and in adults when distended); gravid uterus; sigmoid loop; upper portion of rectum. **Right iliac;** cecum, with vermiform appendix; end of ileum. **Left iliac;** sigmoid colon; convolutions of jejunum and ileum.

Apertures in the Abdominal Wall.—**Above;** those through the diaphragm (see that structure). **Below;** for femoral vessels; for spermatic cord. **Anteriorly;** umbilicus.

Structures of Anterolateral Abdominal Wall.—(From without inward) _ skin; superficial fascia, superficial and deep layers; general areolar tissue overlying external oblique muscle, and special intercolumnar fascia of external abdominal ring; external oblique and its aponeurosis; internal oblique and its aponeurosis; transversalis and its aponeurosis; rectus; pyramidalis; fascia transversalis; subperitoneal areolar tissue; peritoneum.

Structures of Posterior Abdominal Wall.—(**1**) Osseous Portion _ five lumbar vertebræ and interarticular fibrocartilages; posterolateral portions of ilia; _ (**2**) Soft Portion (from without inward) _ skin; subcutaneous areolar tissue; lumbar aponeurosis (posterior layer); erector spinæ; lumbar aponeurosis (middle layer) attached to transverse processes of lumbar vertebræ; quadratus lumborum; lumbar aponeurosis (anterior layer); psoas; crura of diaphragm; kidney, areolar tissue, and colon; subperitoneal areolar tissue; peritoneum.

Arteries of Anterolateral Abdominal Wall.—Superficial epigastric, superficial circumflex iliac, and superficial external pudic from femoral; lowest two intercostals from thoracic aorta; abdominal branches of lumbar arteries from abdominal aorta; iliolumbar from internal iliac; deep circumflex iliac and deep epigastric from external iliac; superior epigastric and musculophrenic from internal mammary.

Arteries of Posterior Abdominal Wall.—Lumbar branches of abdominal aorta.

Veins of Anterolateral Abdominal Wall.—Correspond, chiefly, with the arteries.

Veins of Posterior Abdominal Wall.—Correspond, chiefly, with the arteries.

Lymphatics of Anterolateral Abdominal Wall.—Superficial vessels above umbilicus empty into axillary glands; _ superficial vessels below umbilicus empty into inguinal glands; _ deep vessels above umbilicus empty into sternal glands (probably); _ deep vessels below umbilicus empty into iliac glands.

Lymphatics of Posterior Abdominal Wall.—Median (aortic) lumbar glands; _ lateral (psoas) lumbar glands.

Distribution of Nerves to Anterolateral Abdominal Wall (Fig. 3314).—**Lower intercostal nerves;** emerging from intercostal spaces behind costal cartilages (except twelfth, which is subcostal), they pass forward between internal oblique and transversalis (generally intercommunicating here) _ penetrate outer edge of sheath of rectus _ supply rectus _ pass through its substance _ penetrate anterior layer of rectal sheath _ and are distributed to skin. **Lateral cutaneous branches of lower intercostal nerves;** divide into Anterior Branches (to skin up to outer border of rectus, and superficial part of external oblique) and Posterior Branches (to skin of outer part of back). **Sixth intercostal;** supplies region between lower end of sternum and tip of ensiform cartilage. **Seventh intercostal;** distributed to region near lower end of ensiform cartilage. **Eighth intercostal;** runs up under cover of costal arch and supplies area of middle linea transversa, between tip of ensiform cartilage and umbilicus. **Ninth intercostal;** runs directly forward on level with ninth costal cartilage and supplies region just above umbilicus. **Tenth intercostal;** runs directly forward on level with tenth costal cartilage and supplies skin about umbilicus. **Eleventh intercostal;** runs forward and downward, supplying the region a little below the umbilicus. **Twelfth intercostal;** passes in front of quadratus lumborum, along lower border of twelfth rib – pierces transversalis and runs forward between transversalis and internal

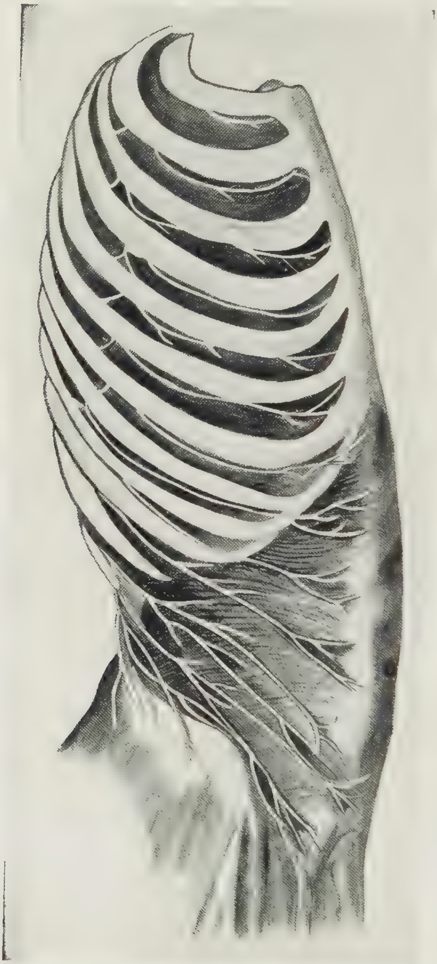
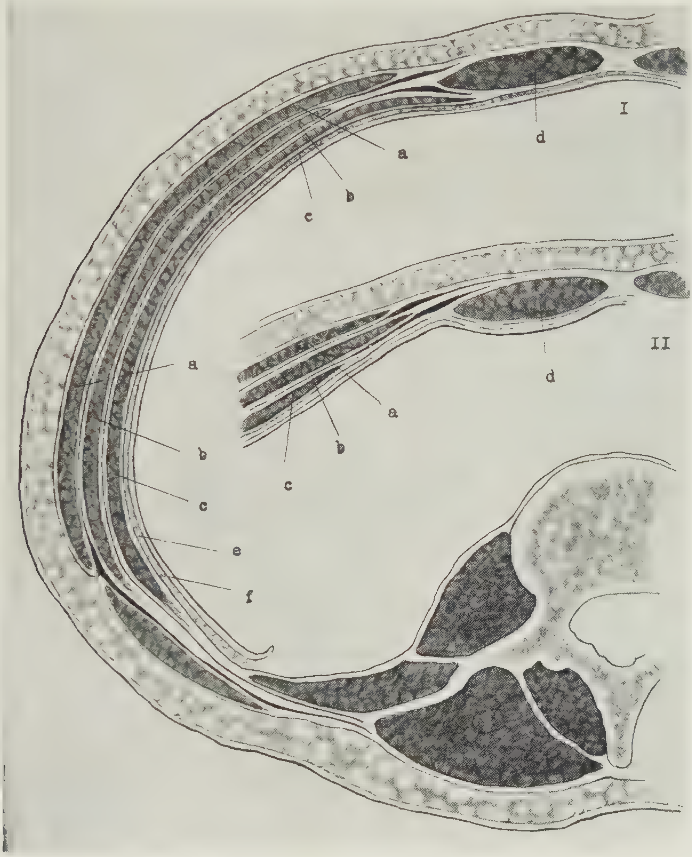


Fig. 3314.—Distribution of Nerves to Anterolateral Abdominal Wall: – The Intercostal (upper six) nerves are distributed to the chest proper; – the lower abdominal intercostal (lower six) nerves pass forward from the intercostal spaces between the internal oblique and transversalis muscles, to the sheath of the rectus. (Modified from Spalteholz.)

oblique _ (*a*) Anterior Branch of Twelfth Intercostal, penetrates rectus and is distributed below a point midway between umbilicus and pubis; _ (*b*) Lateral Cutaneous Branch of Twelfth Intercostal, penetrates internal oblique, then emerges from external oblique from 2.5 to 8 cm. (about 1–3 inches) above the iliac crest, and is distributed to skin over front of hip. **Iliohypogastric branch of first lumbar**; emerges from upper outer border of psoas _ runs in front of quadratus lumborum to iliac crest _ piercing transversalis posteriorly, and divides between transversalis and internal oblique, about 6.5 cm. (about 2½ inches) posterior to anterior superior iliac spine into _ (*a*) Hypogastric Branch, passing forward between transversalis and internal oblique, pierces internal oblique, then pierces aponeurosis of external oblique about 2.5 cm. (about 1 inch) above and just to outer side of external abdominal ring, and supplies skin of hypogastric and external ring region; _ (*b*) Iliac Branch.



Figs. 3315 and 3316.—Transverse Sectional Views of the Muscles and Aponeuroses Forming the Abdominal Wall _ Especially Anteriorly and Laterally: _ I, Above the linea semicircularis, throughout which extent the internal oblique contributes equally to the formation of the anterior and posterior sheaths of the rectus muscle; _ II, Below the linea semicircularis, below which level the fibers of the internal oblique enter into the formation of only the anterior layer of the sheath of the rectus _ the aponeurosis of the transversalis muscle alone passing behind the rectus: **d, d,** Rectus muscle; _ **a, a,** external oblique; _ **b, b,** internal oblique; _ **c, c,** transversalis muscle; _ **e,** transversalis fascia; _ **f,** peritoneum. (Modified from Deaver.)

piercing internal oblique and external oblique directly above crest of ilium, and supplying skin of gluteal region posterior to lateral cutaneous branch of twelfth dorsal nerve. **Ilio-inguinal branch of first lumbar;** passes from outer border of psoas just inferior to iliohypogastric _ runs obliquely across quadratus lumborum and iliacus _ penetrates transversalis near anterior part of iliac crest (communicating here with iliohypogastric) _ runs forward between internal oblique and transversalis, piercing internal oblique a little in front of anterior superior iliac spine _ passes forward beneath aponeurosis of external oblique, accompanying cord through inguinal canal and emerging at external abdominal ring _ supplying skin of upper and inner aspects of thigh _ and scrotum in male, and labium in female.

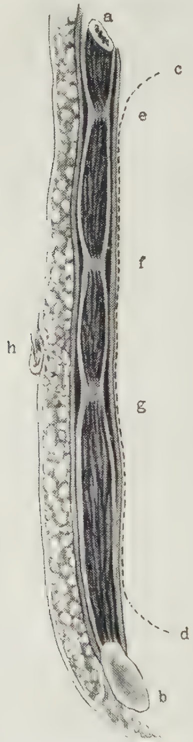


Fig. 3317.—Sectional View of the Median Abdominal Line in the Sagittal Plane _ From the Seventh Costal Cartilage to the Symphysis Pubis: _ **a**, Seventh costal cartilage; _ **b**, symphysispubis; _ **h**, umbilicus; _ **e, f, g**, lineæ transversæ; _ **c, d**, peritoneal reflection.

Distribution of Nerves to Posterior Abdominal Wall.—**Posterior divisions of lumbar nerves;** dividing into internal and external branches. **Genitocrural nerve;** arising from first and second lumbar nerves, passes obliquely through psoas, emerging from its inner border opposite disk between third and fourth lumbar vertebræ _ passing downward upon anterior surface of psoas and dividing, at outer side of external iliac artery, into _ (*a*) Genital Branch, piercing fascia transversalis and descending on posterior part of spermatic cord through inguinal canal _ emerging at external abdominal ring and supplying cremaster muscle in male, and round ligament in female; _ (*b*) Crural Branch, descending on external iliac artery and piercing femoral sheath about 5 cm. (about 2 inches) below Poupart's ligament, to be distributed to skin of upper central part of thigh. **External cutaneous;** arising from second and third lumbar nerves, emerges from center of outer border of psoas and runs obliquely over iliacus muscle to notch just below anterior superior iliac spine, where it escapes beneath Poupart's ligament on to thigh. **Anterior crural; obturator; accessory obturator nerves** _ descend to their distributions through the posterolateral aspect of the abdominopelvic wall.

Summary of Distribution of Anterior Abdominal Nerves.—Seventh and eighth run upward and inward and supply upper third of abdominal wall; _ ninth and tenth run nearly transversely inward and supply middle third; _ eleventh and twelfth, and Iliohypogastric and Ilio-inguinal, run downward and inward and supply lower third of abdominal wall.

Anterior Sheath of Rectus.—Formed, above, by blending of aponeuroses of external oblique and outer lamella of internal oblique _ below, by blending of aponeuroses of external oblique, internal oblique, and transversalis.

Posterior Sheath of Rectus.—Formed, above, by blending of aponeuroses of inner lamella of internal oblique and transversalis; next to which come, in order, transversalis fascia, subperitoneal areolar tissue, and parietal peritoneum, _ below semilunar fold of Douglas, by transversalis fascia alone; next to which come, in order, subperitoneal areolar tissue and parietal peritoneum.

Linea Alba.—A tendinous raphé, extending from ensiform cartilage to symphysis pubis, down median line of abdominal wall, and formed by the union of the aponeuroses of the obliquus externus and internus and the transversalis, between the inner margins of the rectus muscles. Most distinct just above the umbilicus. Practically absent below semilunar fold of Douglas _ because from that line downward the aponeuroses of external oblique, internal oblique, and transversalis all pass in front of rectus (the linea alba being formed by the junction of the anterior and posterior aponeuroses which form the sheath of the rectus).

SURFACE FORM AND LANDMARKS OF THE ABDOMINOPELVIC WALL

Linea alba _ extending from apex of ensiform cartilage to symphysis pubis _ broader above, narrower below the umbilicus _ incomplete posteriorly (only) in its lower fourth, where the transversalis fascia replaces it. One or both borders of the recti are apt to be incised in operating below the umbilicus. Represents junction of inner borders of aponeuroses of the flat abdominal muscles.

Lineæ semilunares _ represent the line of division of the aponeuroses of the abdomen _ correspond with the outer borders of the recti muscles _ extend from lowest part of seventh costal cartilages to spines of os pubis, so curved that opposite the umbilicus they are 6 to 7.5 cm. (2½–3 inches) from the median line.

Lineæ transversæ _ three tendinous intersections in the substance of the recti muscles, forming transverse furrows upon their surface _ the upper one, opposite, or just below, the tip of the ensiform cartilage, _ the middle one, between the tip of the ensiform cartilage and the umbilicus (about opposite the tenth costal cartilage), _ the lower one, opposite the umbilicus, _ (and sometimes a fourth one, below the umbilicus).

Semilunar fold of Douglas _ below which the posterior sheath of the recti is formed by transversalis fascia alone _ about opposite the junction of the upper three-fourths and the lower fourth of the recti muscles _ about 3 cm. (1¼ inches) below the umbilicus.

Abdominal furrow _ extends from infrasternal fossa to, or a little below, the umbilicus, where it becomes lost. Its bottom is formed by the linea alba.

Umbilicus _ situated in the linea alba _ always above the level of the highest points of the crests of the ilia (generally from 2 to 2.5 cm., ¾–1 inch above) _ from 2 to 2.5 cm. (¾–1 inch) above and to the inner side of the bifurcation of the abdominal aorta _ opposite the tip of the third lumbar spine, or the intervertebral disk between the third and fourth lumbar vertebræ. Pendulous abdomens are exceptions.

Spine of the os pubis _ found by following up the tendon of the abductor longus _ nearly on the same horizontal line as the upper edge of the great trochanter _ gives attachment to the outer pillar of the external abdominal ring.

Anterior superior iliac spine _ the most prominent landmark of the lower anterolateral abdominal wall.

Crests of the iliac bones _ continuations backward of the anterior superior iliac spines _ found at the bottom of the iliac furrows, in the fleshy.

Poupart's ligament _ represented by a line curved slightly downward, between the anterior superior iliac spine and the pubic spine.

Iliac furrow _ corresponds to the iliac crests _ and formed by the attachment of the external oblique muscles to these crests.

Sacral promontory—represented by a transverse line between the two anterior superior iliac spines.

Internal abdominal ring—situated about 1.3 cm. (½ inch) above the center of Poupart's ligament.

External abdominal ring—situated just superior and external to the crest of the os pubis.

Aponeuromuscular limits of external oblique _ the line representing the junction of the aponeurotic and muscular portions anteriorly, is one passing from the anterior superior iliac spine to the ninth costal cartilage (or one slightly anterior to these points); _ The lower limit of the fleshy part of the external oblique is represented by a transverse line from a point on the iliac crest 2.5 to 5 cm. (1–2 inches) posterior to the anterior superior iliac spine, to a corresponding point on the opposite side. The fibers of the muscle and aponeurosis run about at a right angle with a line from the anterior superior iliac spine to the umbilicus.

Aponeuromuscular limit of the internal oblique _ Above, by an oblique line from a point below the anterior end of the twelfth rib extending upward parallel with the costal arch, _ Internally, by a line extending from the middle of Poupart's ligament upward and slightly outward. The upper line marks the upper limit of the muscular part.

Aponeuromuscular limit of the transversalis _ the median limit of the fleshy part of the transversalis is nearer the middle line of the body above and below than at the center.

Deep epigastric artery _ runs from a point just internal to the middle of Poupart's ligament upward and inward to the inner aspect of the internal abdominal ring _ thence still upward and inward to about midway between the pubes and umbilicus _ and, passing beneath the semilunar fold of Douglas, runs between the sheath of the rectus and the muscle, finally piercing the muscle.

Abdominal aorta _ bifurcates about 2 cm. (¾ inch) below and to left of the umbilicus.

Celiac axis _ situated from 10 to 12.5 cm. (about 4–5 inches) above the umbilicus.

Superior mesenteric and suprarenal arteries _ arise just below the celiac axis.

Renal arteries _ arise about 1.2 cm. (½ inch) below the superior mesenteric.

Inferior mesenteric _ arises about 2.5 cm. (1 inch) above the umbilicus.

Peritoneal reflection from bladder on to lower abdominal wall _ see under the Bladder.

Posterior superior spinous process of ilium _ generally marked by a depression on a level with, and on either side of, the spinous process of second sacral vertebra.

Spinous process of third sacral vertebra _ generally to be felt below the second sacral vertebra, which last is nearly always detectable.

Outer border of erector spinæ _ generally felt by deep palpation made to the outer side of and parallel with the vertebral column. See Surgical Landmarks of the Kidney.

GENERAL SURGICAL CONSIDERATIONS IN OPERATIONS UPON THE ABDOMINOPELVIC WALL AND CAVITY

Guide to the choice of special abdominal incisions – that incision should be chosen which most satisfactory accomplishes the following (in order of importance): – free access – avoidance of nerves – separation of muscular and aponeurotic fibers rather than their division – avoidance of vessels.

Separation of the fibers of muscles and aponeuroses in their cleavage line should always be done in preference to a division of those fibers transversely or even obliquely.

Blood-vessels, as compared with nerves, are of secondary importance – though the deep epigastric artery (the most important of the abdominal wall), and its anastomosis with the superior epigastric of the internal mammary, should be spared when possible.

Better to cut through muscle than through aponeurosis (where cleavage separation is not possible) – as the former is more resistant to hernia (Hyrtl).

Median Incisions – available for parts most accessible thereby. Through a median incision above the umbilicus; the stomach, liver, pancreas, and intestines may be reached. Through a median incision below the umbilicus; the intestines, bladder, ureters, uterus, and ovaries may be reached.

Lateral Vertical Incisions – (along the outer border of the rectus) – not advisable ordinarily, as they divide the motor nerves to the rectus muscle, and thereby predispose to hernia. When done, generally done for the gall-bladder and ducts, duodenum, ascending and descending colons, spleen, and kidneys.

Transverse or Slightly Oblique Incisions – preferable for reaching those sites laterally placed. The incisions are more or less parallel with the nerves – the muscles are separated in their cleavage lines, where possible, and retracted – the nerves are recognized in the intermuscular planes (especially between internal oblique and transversalis) and held to one side. This incision may be used for the appendix, ascending and descending colons, kidneys, stomach, liver, gall-ducts, intestines, and ureters.

Special Abdominal Incisions – see the different methods of abdominal section following.

In the above summary of abdominal incisions no hard-and-fast rule exists as to their application – it merely being meant to mention some cases in which each category of incisions may be used – more specific data being given under the different viscera.

All abdominal incisions should avoid, where possible, the anterior branches of the dorsal and lumbar nerves – which run obliquely from behind downward and forward between the muscular abdominal planes. The lower abdominal nerves run inwardly somewhat more transversely than do the fibers of the external oblique muscle and aponeurosis – so that in an oblique incision parallel with the fibers, one or more nerves may be encountered – but should be recognized, and can generally be spared.

All vertical incisions of the abdominal wall, of any length, except those in the median line, cut one or more nerves.

Vertical incisions over the center of the rectus divide the motor nerves to the inner half of the rectus muscle.

Long cutaneous and fascial incisions are harmless – and are desirable if thereby free access to the site be gained.

Longer incisions are necessary in the intramuscular separation than where the muscle-fibers are cut.

Longer incisions are necessary in very fat and thick abdominal walls.

Hernia is more apt to follow incisions in the lower than in the upper part of the abdomen _ and in the anterior rather than in the lateral and posterior portions.

Linea alba is broader above than below the umbilicus, hence both inner rectal borders are more likely to be exposed by a median incision below than above the navel. If it be desired to identify the linea alba, after cutting through the superficial fascia, make a slightly oblique superficial incision over the median line _ until the linea alba is recognized as a white fascial line or as a cord extending between the inner borders of the recti.

Pyramidales (one or both) may overlap the median line and their fibers may be divided in a median abdominal section performed low down.

Lineæ transversæ do not extend all the way through the rectus to its posterior aspect.

Avoid cutting through the umbilicus, ordinarily. Also pass slightly to its left to avoid the round ligament. Incision may be made directly through the center of the umbilicus itself _ inclining slightly to the left just above it, to avoid the round ligament. Kelly mentions, after cutting through the umbilicus, that it is well, in closing the wound, to "split it on each side before putting in sutures, to convert the naturally thin surface between skin and peritoneum into a broader area for better approximation."

If the round ligament of the liver be cut during operation, no harm of consequence is done. It should be repaired with chromic gut suture.

Peritoneum is more loosely connected with the linea alba above and below the umbilicus _ and more closely in the neighborhood of the umbilicus.

A transverse vessel in the subcutaneous fat, about 2 cm. ($\frac{3}{4}$ inch) above the symphysis pubis, is mentioned by Kelly, which spouts arterial blood from one side and venous blood from the other when cut. He also mentions one or more veins ("celiotomy veins") lying just over the peritoneum in the lower third of the linea alba, running very nearly parallel with the linea alba and ending in the vesical plexus at the neck of the bladder.

Empty the bladder before operating _ and, if necessary, outline the bladder with a sound during operation.

In all operations involving the pelvic and lower abdominal regions, the Trendelenburg position is desirable _ causing a displacement of the intestines and viscera above away from the field of operation. It should be assumed just before the operation and continued during it _ at an angle of from 18 to 45 degrees, the average being about 30 degrees.

Intestines and viscera are best held out of the way by means of flat pads of sterilized non-absorbable cotton covered with non-absorbable gauze.

As soon as the peritoneum is incised, and in order to make less likely the stripping of the peritoneum from the muscular wall, a silk ligature may be passed into either lip of the peritoneum, including the muscular wall, and used as a retractor, after being knotted.

In incising the abdominal wall the peritoneum is at first only opened to a limited extent _ the opening being increased after intra-abdominal examination by means of a finger introduced.

Avoid mistaking the transversalis fascia for subserous areolar tissue _ and subserous areolar tissue for omentum _ and especially intestine for peritoneum.

In cleansing the abdominopelvic cavity the natural fossæ should receive especial attention . especially Douglas' culdesac, rectal, duodenal, jejunal, renal, and cecal.

Large parts of the omentum may be ligated off and removed, if indicated.

Suture materials _ For peritoneum; fine, plain catgut. For fascial and aponeurotic planes; chromic gut, kangaroo-tendon, silk. For muscles; chromic gut, plain gut, silk, kangaroo-tendon. For subcutaneous tissue; plain or chromic gut, silk. For skin; silkworm-gut, silk (gut).

Avoid including omentum and intestinal walls in the tightening of sutures.

Just before tightening the last suture or two press upon the abdominal wall to expel air or fluids.

Quilt sutures may be used for the fascial planes of suturing.

Relaxation sutures may be used _ about 2.5 cm. (1 inch) apart, and from about 1.2 to 2 cm. ($\frac{1}{2}$–$\frac{3}{4}$ inch) from the edges of the wound.

In all kinds of suturing the process is aided by the use of wound-hooks, which render the edges straight, parallel, and tense, and lift away the abdominal wall from the underlying intestines and viscera.

Sutures are removed from the seventh to the tenth day.

Muscles should be separated in the line of their cleavage, and not divided transversely _ and when nerves are encountered in the course of an incision, every effort should be made to retract rather than divide them.

If the abdomen be opened through a vertical incision of any length, through the outer part of the rectus, and the nerve-supply be cut, atrophy of the part beyond may be expected, and hernia _ but if an incision of the same length be made through the outer aponeurosis of the rectus, down its inner third, or even outer third, and then the rectus be retracted from within outward, and an incision be made through the posterior sheath opposite the one made through the outer sheath, no harm will be done to the nerves of the part. At the end of the operation the posterior sheath is sutured _ and the rectus allowed to fall back into place _ after which the anterior sheath is sutured.

An incision of approach should be amply large to accomplish the purpose without too much tugging upon the wound margins, and without jeopardizing adjacent structures _ and cosmetic effect should be sacrificed to the more practical bearings of the case. It is no creditable reflection to remove an appendix "by an incision of an inch and a half, in a minute and a half," if traumatism to neighboring parts be committed (which must often thereby occur) which could be avoided by a 3-inch incision, consuming three minutes for its execution.

If muscles must be divided transversely, or obliquely, they should be sutured with catgut at the end of the operation.

While incisions should be made long enough for practical purposes, they should not be made unnecessarily long, simply because it is easier and more comfortable to operate through such incisions.

The general and local preparations are those of a major operation _ and are given in Vol. I, pp. 1–84.

The abdomen is, under ordinary conditions, usually opened with the patient in the horizontal, dorsal decubitus. Subsequently, he can be placed in the head-down (Trendelenburg) position, to expose the pelvic region _ or in the feet-down position, to expose the upper abdomen.

While an incision passing through the middle third of the median line usually passes to the left of the umbilicus (to avoid the round ligament), it sometimes passes to the right _ or the entire navel may be excised (except in young women) by a narrow elliptic incision.

The means of keeping the patient warm, through artificial heat, during operation, should be provided _ especially by such measures as an electrically heatable table covering.

Various forms of incision are made for exposing the abdominopelvic region _ the most frequently employed being here given in the following pages. Other special types of incision will be described in connection with those structures where they are particularly applicable.

OPERATIVE TREATMENT OF WOUNDS OF THE ABDOMINOPELVIC WALL

Wounds which do not penetrate the peritoneum, though they go down to it, do not ordinarily present unusual features _ unless very extensive, or very destructive of the abdominal wall.

If the element of penetration of the abdomen be eliminated _ (and it is better surgery to carefully enlarge the wound to determine this, rather than run the risk of infecting the peritoneal cavity by probing down, upon routine principle through a soiled wound of the abdominal wall) _ then infection of the wound tract, and bleeding, are the two next most important considerations. As the vessels of the abdominal wall are small, hemorrhage is not apt to be great unless the wound be extensive. Bleeding vessels should be exposed and tied. The wound must be cleansed as well as the circumstances of the special case will permit.

The repair of the wound will depend, for detail, entirely upon its nature. Cleanly incised wounds are the simplest. Component structures of the abdominal wall, especially those constituting its strength, should be anatomically repaired with absorbable sutures _ which will be more difficult when they are divided transversely and obliquely, than when divided in the cleavage line of the individual structure _ and closed with or without drainage as indicated.

Larger, more ragged wounds will often present considerable difficulty _ and may require some extensive technic of plastic surgery for their repair _ making use, by mobilization, of neighboring muscles and aponeuroses _ as the plastic repair of the abdominal wall after the removal of moderate, or large utmors, whose excision represents considerable loss of abdominal wall substance.

Wounds which penetrate the abdominal wall will be considered under the Peritoneum _ whose involvement together with that of the contained structures constitutes their chief feature and importance.

GENERAL INSTRUMENTS EMPLOYED IN ABDOMINAL SECTION

Scalpels; scissors, straight, curved, sharp and blunt; forceps, dissecting and toothed; artery-clamps, various; special retractors; taped and clamped gauze pads; gauze sponges on holders; suction-drain outfit; drainage-tubes, or drains; wound-hooks; needles; needle-holder; Reverdin-needle; plain and chromic catgut ligatures; sutures of plain and chromic catgut, kangaroo-tendon, silk, linen, silkworm filament.

OPERATION FOR THE REMOVAL OF TUMORS OF THE ABDOMINOPELVIC WALL

These come within two categories _ Those involving the surface and superficial layers of the abdominal wall _ Those involving the entire thickness of the abdominal wall.

Tumors Involving the Surface and Superficial Layers of the Abdominal Wall.—If small _ they are generally removable by wedge-shaped elliptic incisions surrounding them _ after which the walls of the wound are brought together by buried and superficial sutures.

If large _ their removal may often still be accomplishable upon the same principle, but upon a larger scale. In other instances, however, too much tissue may be removed to admit of the approximation of the remaining wound surfaces. In the latter event, plastic methods of approximation must be resorted to _ such as undercutting the neighboring structures sufficiently to enable them, by mobilization, to come together. If the excision of the mass involves the division of muscles and aponeuroses in their entire thickness, these should be plastically repaired in the wound closure – which also may only be accomplishable through methods of mobilization.

Tumors Involving the Full Thickness of the Abdominal Wall.—If a benign tumor, though large, involve the entire thickness of abdominal wall, but does not invade the peritoneum, it will probably be possible to plan an operation which will admit of excising the tumor, and also make provision for the plastic repair of the remaining wound walls. In tumors, both benign and malignant, which involve all the structures which enter into the make-up of the abdominal wall, it is often necessary to operate upon the same general principles as one would for an extensive abdominal hernia, in which the tumor mass excised would represent the neck of the hernia (and might be even larger than the average neck) – and where, following elliptic excision of the full thickness of wall, abdominal muscles and aponeuroses would have to be variously split and mobilized as the only available means of plastic repair of the damaged wall which would promise strength sufficient to withstand hernia. Such measures will be fully described in connection with umbilical and ventral herniæ.

OPERATIVE TREATMENT OF ABSCESSES OF THE ABDOMINOPELVIC WALL

Abscesses of the abdominal wall may be superficial, subaponeurotic, intermuscular, intramuscular, or subserous – acute or chronic – primary, or secondary.

The indication – independently of variety, site, or cause – is evacuation of the contained pus, by the simplest route, with the establishment of drainage.

It is especially indicated to operate early, and to follow up the process to the source of suppuration – for delay, or inefficient opening, has been followed by considerable pus dissection in the fascial and muscular planes.

There are no features peculiar to the method of opening these abscesses that are not common to abscess opening, in general.

Abscesses of certain localities may present special local features – such as those of the para-umbilical region, of the prevesical space, and the like.

EXCISION OF THE UMBILICUS FOR TUMOR (UMBILECTOMY)

Two conditions may arise – one, in which the umbilicus may have to be excised for involvement by a benign tumor, or other condition, in which it is not necessary to incise the full thickness of the abdominal wall – and the other, in which, for malignant growth, the umbilicus itself and the immediately adjacent abdominal wall may have to be excised in its entire depth.

Superficial Excision of the Umbilicus.—In minor grades of involvement it may suffice to remove the umbilicus by an encircling elliptic incision. The ends of the ellipse lie in the median line – and the incision passes down to or through the aponeurosis of the right and left rectus. The excised mass, therefore, will consist of skin, umbilicus, and fatty areolar tissue – with or without part of the outer sheath of the rectus. In closing the wound, if the rectal sheath have not been incised, the fatty wall is simply first approximated by buried, absorbable sutures – after which the skin margins are united. If the anterior layer of the rectal sheath have been incised, the margins of this sheath should be sutured, in the act of closure, by the overlap method – so that no invitation to hernia at the site of the former umbilicus may be left.

Excision of the Umbilicus Involving the Full Thickness of the Abdominal Wall.—This is a much more pretentious procedure – and the technical steps largely follow those of the operation for umbilical hernia (q. v.) –

though the complications, especially from massive adhesions, are not apt to be so troublesome. A more liberal allowance of tissue is made in calculating the ellipse – whose axis, as in the minor grade of operation, usually corresponds with the median line. After deepening the contour of the incision everywhere down to the aponeuroses of the two recti, it may be possible to somewhat narrow the ellipse which is to pass through the rectal sheath – which, if it can be safely done, will make the repair easier. The incision is carried down through the full thickness of the abdominal wall exactly as is done in operating for umbilical hernia. The peritoneal cavity should be finally entered in the median line, either above or below the tumor – and through the opening thus made, an examining finger is introduced, to determine whether adhesions or other complications exist. Upon the knowledge thus secured, and with the protection of a finger within the abdominal cavity, the entire ellipse is excised. In making the closure, even very much more important is it than in the above operation, to close the wound by the overlapping method of approximating the anterior and posterior layers of the rectal sheaths, as the abdominal wall would be otherwise very much weakened at site of removal. The details of the closure are, otherwise, the same as those following median abdominal section.

OPERATION FOR EXCESS OF FATTY ABDOMINAL WALL – ABDOMINAL LIPECTOMY

Description.—Excessively enlarged abdominal walls, from overgrowth of the fatty connective tissue, is chiefly encountered in very obese women, and sometimes among those who have borne many children. Doyen mentions that this adipose reduplication of skin, or apron, may weigh up to 1500 or 2000 grams. And Kelly removed one such abdominal apron (complicated in his case, however, by an umbilical hernia) in which the patient weighed 464 pounds.

As the condition seriously and mechanically handicaps the patient – interfering with bodily care, with sexual intercourse, with dress, causing intertrigo, and the like – the removal of the fatty mass is often indicated – and has been frequently successfully performed. In Kelly's case a piece of tissue measuring, vertically, 19 inches and, transversely, 36 inches, was removed. The wound healed perfectly, and the patient was reported in excellent health eight months afterward.

Operation.—The skin and underlying adipose tissue, of the pendulous or protuberant portion of the abdomen, is outlined by an elliptic incision – so planned that, laterally, its limit will be far enough outward, and, vertically far enough apart in the median line, that when the redundant portion of cutaneo-fatty-areolar tissue is removed, the upper and lower walls, left after the excision, will come well and easily together. The section is made very much as one cuts out the segment of a circular cake – and the amount of tissue to be sacrificed is very carefully planned in advance (and definitely marked upon the skin) as a result of the Surgeon's examination of the patient's abdominal wall, both in the standing and in the horizontal positions – taking the movable parts of the upper abdominal wall, under one hand, and those of the lower abdominal wall, under the other, and approximating them. The resulting raw surfaces must come together without a degree of tension which in itself would serve as an element militating against union.

If too much tension result in gaping, in the depths of the wound, hematoma is apt to form, and prove difficult to deal with. If too much tension be placed upon the skin margins, the stitches may tear out, or union be imperfect. In some cases the ellipse has begun within 3 inches of one side of the spine, and extended to the corresponding site upon the opposite side _ thus entirely circumventing the patient, with the exception of some 6 or 8 inches. The form of the wedge-shaped piece of abdominal wall tissue removed is shown in Fig. 3318. The maximum vertical extent of the tissue removed will lie in the median line _ and will be determined by the amount of excess to be removed in the individual case _ as determined by manipulation of the parts.

The incision crossing the abdominal wall may be made along either the upper or lower line first _ and passes in a straight line tilted obliquely, wedge-shaped, directly down to the aponeuroses of the abdominal muscles, but nowhere through these aponeuroses (which are the chief strength of the abdominal wall) _ and should be made with a knife of fairly large size and length (an amputating knife, of the old type, not being necessary, as sometimes suggested). The upper part of the cut should be made with one sweep of the knife _ and at once deepened to the aponeuroses. Bleeding will at first be free _ but all vessels should be at once clamped _ or, if the bleeding be really excessive, abundant gauze compresses may be packed into the wound until all the vessels can be clamped. The opposite incision is then made _ and the mass of soft parts at once freed from the aponeuroses. This will furnish free access to both walls from which hemorrhage is coming _ when all clamped vessels should be tied with catgut. It is of practical importance to see that no bleeding will occur following suture of the wound, as distending hematomata may result in interference with union and very extensive gaping, and an indefinite convalescence through suppuration and granulation. It is to be remembered that union is to occur between walls of fatty tissue, which is not the best grade of tissue for union.

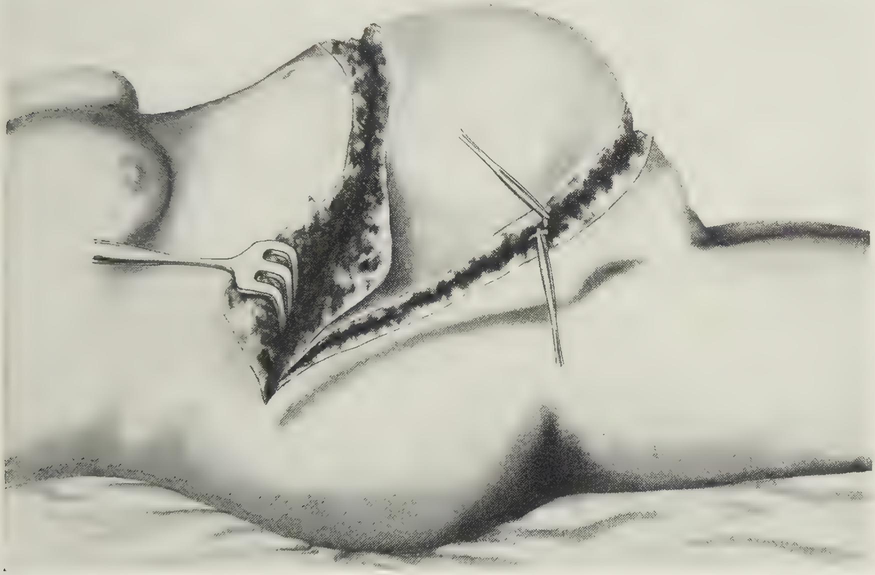


Fig. 3318.—Partial Excision of Redundant Fatty Abdominal Wall _ I; _ The line of elliptic incision.

The suturing of the deeper parts is accomplished by tiers of buried chromic gut sutures, applied, preferably, with a Reverdin needle _ and while the opposite walls are held in accurate and easy contact between the opposite hands of an Assistant _ the number of tiers dependent upon the thickness of the wall (Fig. 3319). Relaxation sutures may be employed if desired.

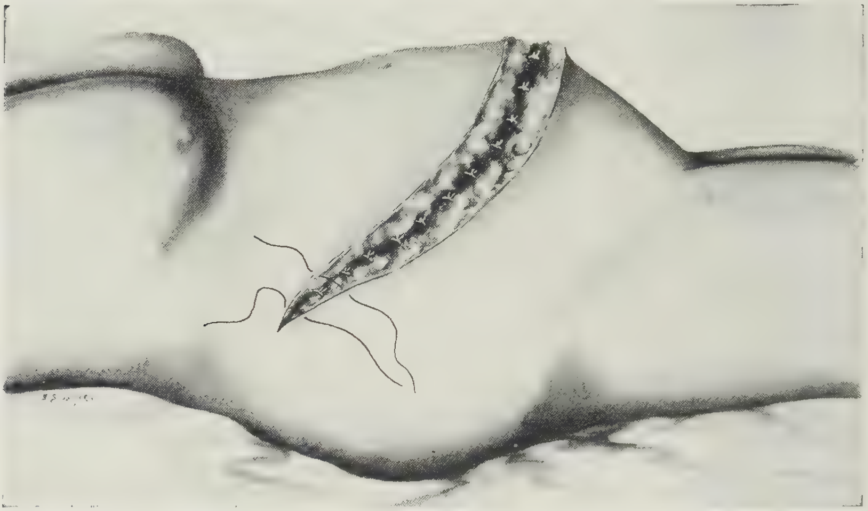


Fig. 3319.—The Same _ II; _ Placing tiers of buried sutures to approximate the walls of long, deep, heaving wound.

The skin is best sutured with silk _ and, over this line of suturing, a narrow, pleated strip of gauze may be laid _ and, then, the entire line may be reinforced

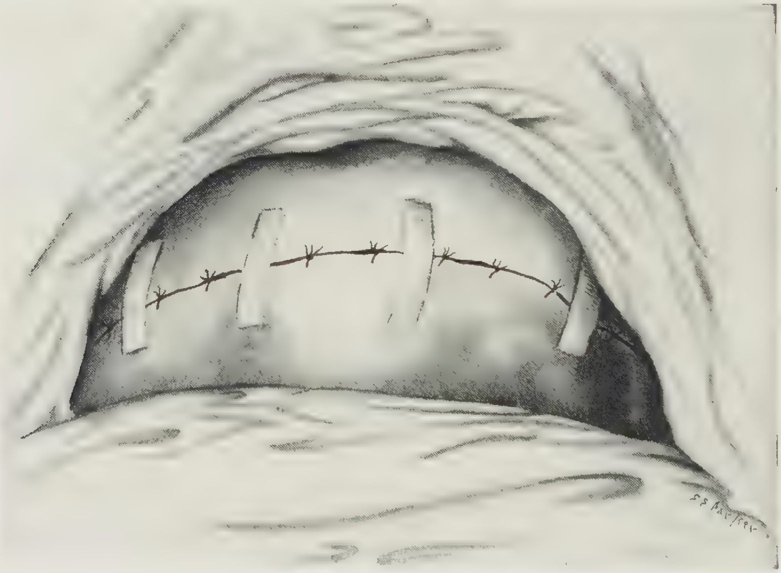


Fig. 3320.—The Same _ III; _ The closure of the skin line with silk sutures _ and the tension relieved by strips of sterile zinc-oxid plaster.

by strips of broad sterile zinc-oxid plaster _ which will largely remove tension from the suture line (Fig. 3320).

HERNIÆ OF THE ABDOMINOPELVIC WALL

As herniæ form such a large class of pathologic conditions, their operative treatment will be considered in a chapter to itself (Chap. LXIII).

PLASTIC REPAIR OF THE ABDOMINOPELVIC WALL

The plastic repair of the weakened, relaxed, and protuberant abdominopelvic wall is considered in the chapter upon Herniæ (Chap. LXIII) – of which such a condition is a relative form. Indeed, all operations for the radical cure of herniæ of the abdominopelvic wall may be regarded, practically, as plastic work upon the abdominopelvic wall.

OPERATIONS FOR THE EXPOSURE OF THE ABDOMINAL CAVITY, IN GENERAL

Many special lines of incision for reaching special organs or structures or for special purposes, in connection with intra-abdominal work, are in use – which will be mentioned under the various abdominopelvic viscera to which they more appropriately apply – for of necessity some form of abdominopelvic section must be made in advance of dealing with any of the intra-abdominopelvic structures.

The operations for exposing the abdomino-pelvic cavity, described in the present chapter, are of general application – and are not here given with reference to any special technic to be followed out after entering the peritoneal cavity. Their use will often be referred to under the special organs to be considered in the following chapters.

MEDIAN ABDOMINAL SECTION

BY THE ORDINARY METHOD

Description.—The opening of the abdominal or abdominopelvic cavity through an incision in the median line of the abdominopelvic wall. The site of this incision may be anywhere between the tip of the ensiform cartilage and the symphysis pubis – dependent upon the object of the operation. Abdominal section, except in cases where done for exploration, is generally but the preliminary step preceding some special operation.

Preparation.—Anterior abdominal wall shaved, especially along site of linea alba. Recesses of navel thoroughly cleansed. Bladder is emptied, especially if incision is to extend very low.

Position.—Patient supine, at edge of table, with arm beneath back. Operation site is walled off with sterilized towels. Surgeon on right, cutting from above downward, or the reverse, Assistant opposite.

Landmarks.—Median line (linea alba). The center of the lower portion of the sternum, the umbilicus, and the suprapubic notch all are in the median straight line of the body in the normal abdomen (Fig. 3321).

Incision.—Is placed directly in the median line – above, below, or including the umbilicus, as indicated. If more room be needed than planned in the original incision, it may be gotten by continuing the incision upward or downward. After incising to within 5 cm. (2 inches) of the bladder, great care should be exercised and the bladder protruded away from the line of incision by the fingers of the left hand – for, although empty, if adherent unusually high, it may be wounded. In passing the site of the umbilicus the incision may be carried directly through its center, with a slight tendency to the left just above the umbilicus, to avoid the suspensory ligament of the liver – or may pass, when quite near the upper or lower aspects of the umbilicus, in a curved direction around it _ the curve passing to the left, thereby avoiding the round or suspensory ligament (the remains of the fetal umbilical vein) between the umbilical fissure of the liver and the umbilicus _ which is, in consequence, left adherent to the right lip of the wound. (See Fig. 3321, A and B.)

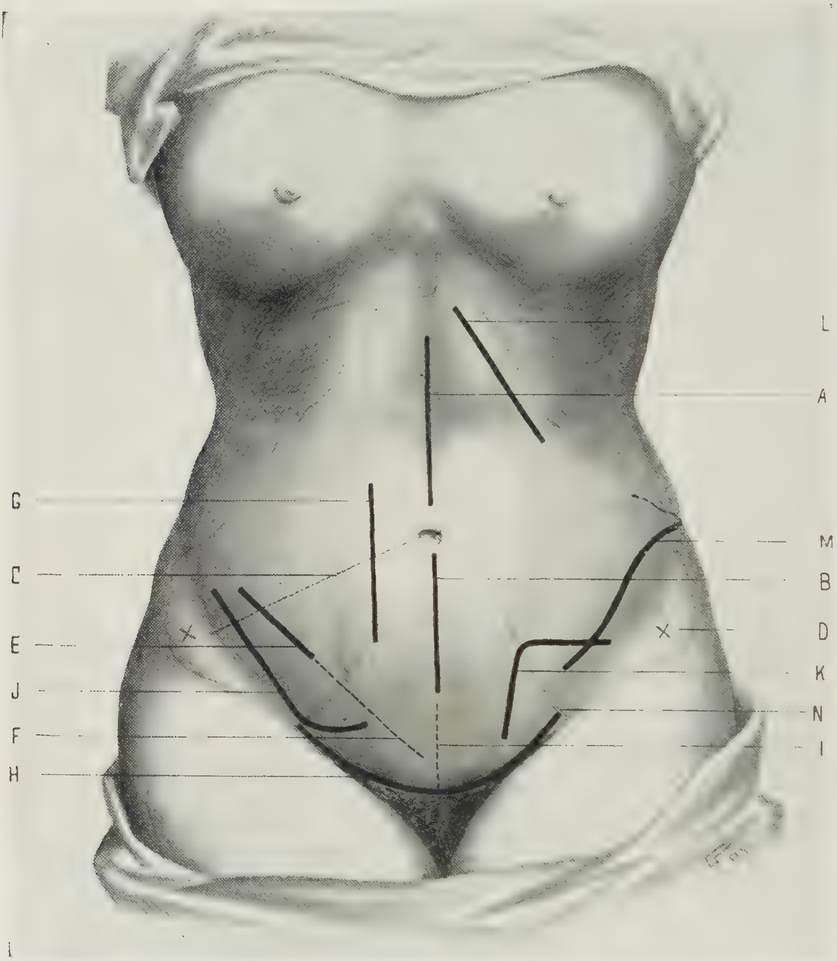


Fig. 3321.—INCISIONS FOR ABDOMINAL SECTIONS: _ A, Median abdominal section, supra-umbilical; B, median abdominal section, infra-umbilical; C, imaginary line from umbilicus to anterior superior iliac spine; D, anterior superior iliac spine; E, incision for McBurney's intramuscular abdominal section; F, incision (skin portion) for Weir's prolongation of the anterolateral intramuscular abdominal section; G, the Battle-Jalaguier-Kammerer incision; H, superficial transversely curved incision of Pfannenstiel's median inferior abdominal section; I, deep vertical incision of Pfannenstiel's median inferior abdominal section; J, Meyer's "hockey-stick" incision; K, Fowler's angular incision; L, oblique subcostal incision; M, Vischer's lumbo-iliac incision; N, position of deep epigastric vessels.

Operation.—Having steadied and rendered tense the abdominal wall by left thumb and forefinger (or middle finger) on either side of the median line, the incision is made the full length of the predetermined distance, at one clean sweep of the knife, passing through skin and connective tissue.

In very fat subjects the skin and thick fatty areolar tissue may be divided by two or three successive sweeps of the knife. Throughout the passage through the abdominal wall, all incisions should be made the full length of the original skin incision. When the peritoneum is nearly reached, the deepest fascia may be separated by blunt dissection.

Continuing to retract the lips of the wound with the left thumb and forefinger, the fascia is partly incised and partly separated, down to the rectal aponeurosis (Fig. 3322). Clamp all bleeding vessels upon the lips of the wound as they are severed _ and at once tie, with catgut, those likely to continue bleeding.

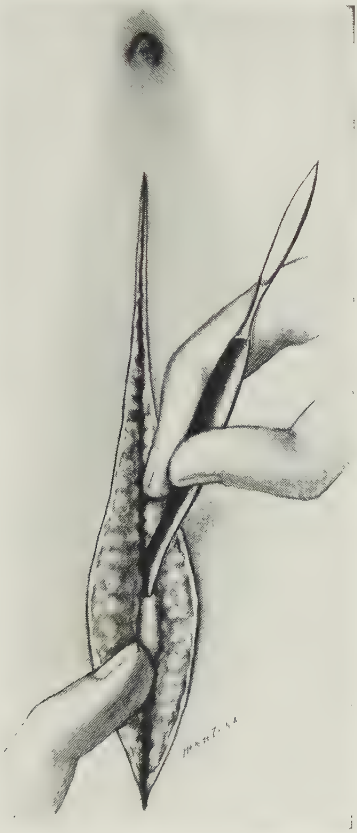


Fig. 3322.—Median Abdominal Section _ Opening the Abdomen _ I; _ Separating the superficial fascia, in the line of the skin incision, by sharp and blunt dissection with the handle of the scalpel.

Incise the abdominal aponeurosis directly in the median line. While aiming to cut between the inner margins of the recti muscles, along their line of junction, without dividing their muscular fibers, it is found, especially when operating below the umbilicus, that frequently one or both recti, together with their sheaths, are cut, or the pyramidales, where the latter overlap inwardly. The linea alba is not as distinct below the umbilicus as above it. In the upper three-fourths of the anterior abdominal wall, directly in the median line, after passing through the skin and fascia, one divides the aponeurosis between the inner borders of the recti; and just to one side of the median line, one divides the outer layer of the rectal sheath, the rectus muscle, the inner layer of the rectal sheath (which inner layer is formed by the aponeurosis of the transversalis and inner lamella of the internal oblique). In the lower fourth of the anterior abdominal wall, directly in the median line, after passing through skin and fascia, one divides the aponeurosis between the inner borders of the recti; and just to one side of the median line, one divides the outer layer of the rectal sheath, the pyramidalis, the rectus muscle, and comes directly down upon the transversalis fascia, which here alone forms the posterior layer of the rectal sheath (Fig. 3323). All bleeding vessels encountered in passing through the aponeurotic and muscular planes of the abdominal wall are clamped or tied.

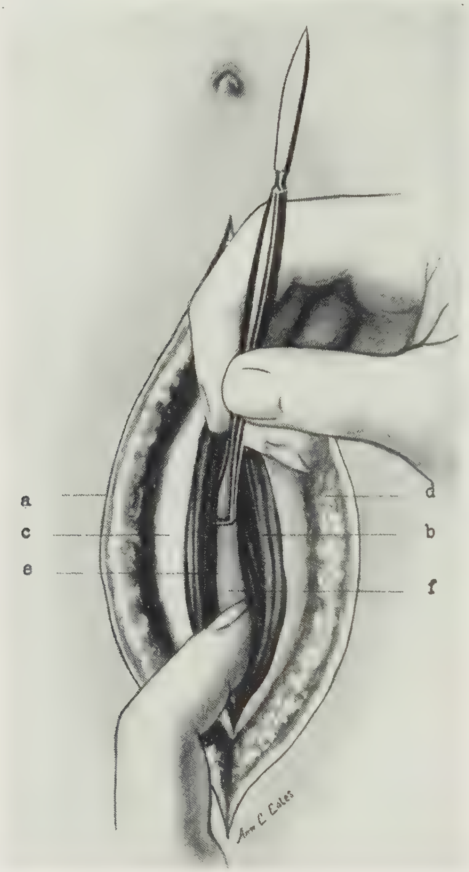


Fig. 3323.—The Same _ II; _ Following the division of the skin, fascia, and rectal sheath, the recti muscles (and the pyramidales, if the incision be low enough) are separated in the middle line by blunt dissection. Where the median line is not accurately cut down upon, or is not recognized, the fibers of the rectus muscle are separated in their cleavage line, in what appears to be the situation of the linea media: **a,** Skin; _ **d,** superficial fascia; _ **c,** rectal sheath; _ **b,** rectus muscle; _ **e,** subserous areolar tissue (not depicted); _ **f,** peritoneum lying directly under the subserous connective tissue.

The fascia transversalis is now exposed in the whole length of the wound, lying beneath the posterior layer of the rectal sheath in the upper three-fourths of the linea alba _ and forming the posterior layer in the lower fourth _ and is similarly incised. The subperitoneal areolar tissue lies between the transversalis fascia and the peritoneum, and is generally divided together with the transversalis fascia. It may be quite thick in the very fatty. All clamped vessels are now tied before opening the peritoneum.

The peritoneum is now encountered lying directly beneath the subperitoneal areolar tissue _ its position being anticipated by a recognition of the structures and layers through which the incisions have passed _ and its actual presence is further recognized by its commoner characteristics, available in the majority of cases _ its glistening, bluish, arborescent surface, and tough nature (which are less available in adhesions and other abnomalities). Having controlled all bleeding, the peritoneum, the final barrier to the peritoneal cavity, is now to be opened. It is important that the peritoneum should be isolated from all underlying structures, and especially the intestines, before being incised. This is best done by picking it up lightly with a pair of toothed forceps, in the form of a small fold. Thus grasping the peritoneum (Fig. 3324) the forceps should be shifted laterally and vertically to determine that they hold nothing in their teeth but peritoneum alone. Should intestines, omen-

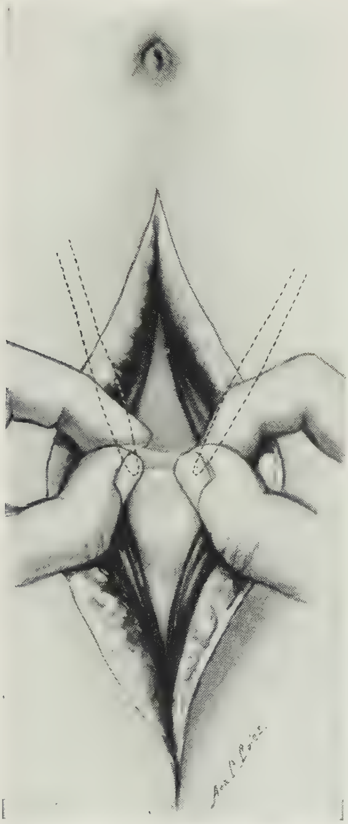


Fig. 3324.—The Same _ III; _ Safe-guarding the intestines in incising the peritoneum _ accomplished as here shown, in either one of two ways: _ Either the finger and thumb of each hand, picking up a transverse ridge of peritoneum, simultaneously push the intestine downward, out of the way; _ Or, two clamp-forceps, grasping the peritoneal ridge laterally, in the free space (now occupied by the fingers), draw it prominently upward, while the transverse ridge thus formed is carefully and limitedly cut with knife or scissors.

tum, or other structures have been grasped, in addition to the peritoneum, a new and lighter hold should be taken. While thus held in the grasp of the forceps – or, better still, between the grasps of two pairs of forceps, one held by the Surgeon and the other by the Assistant (Fig. 3325) – the peritoneum is at first opened to a very limited extent, by making a carefully guarded scissors-cut or knife incision, in the median line, near the tip of the single pair

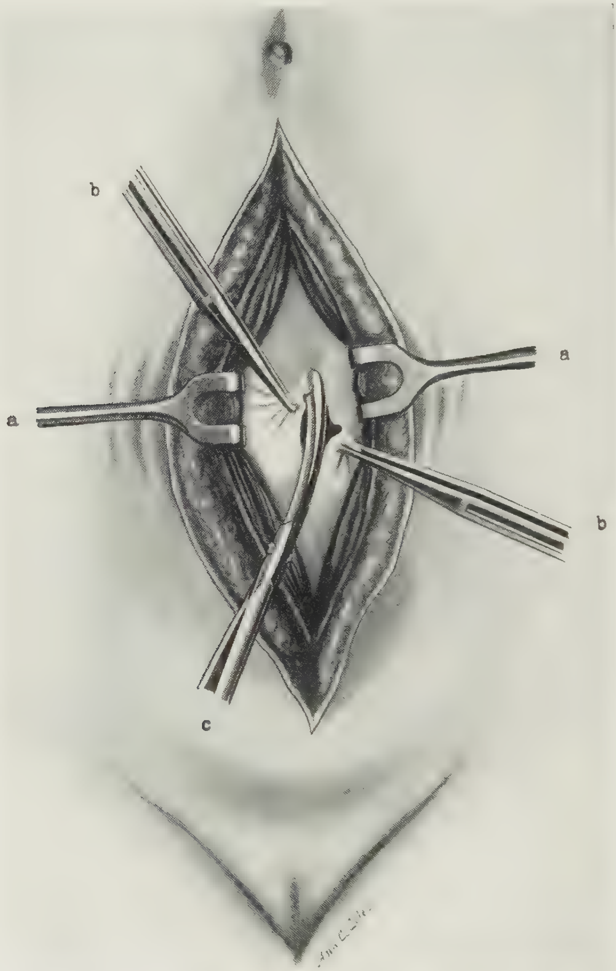


Fig. 3325.—The Same – IV; – Making and lengthening the peritoneal incision: – **a, a,** Retractors drawing aside the skin, connective tissue, rectal sheath, and recti; – **b, b,** forceps (here shown as ordinary toothed forceps) are tensing the transverse ridge of peritoneum (which has been pushed somewhat obliquely in the technic); – **c,** the lower blade of the blunt-pointed scissors, which have cut into the peritoneum, has been made to hug the under surface of the peritoneum, through which it may be seen (by depressing the handles). In first incising the transverse peritoneal ridge, with the blunt ends of the blades, the scissors are held vertically, at right angles to the ridge – after which the handles are depressed until the tip of the blade within the peritoneum hugs the under surface of the peritoneum, in the act of lifting the peritoneum upward – its contour being thus visible through the peritoneum, and thereby demonstrating the absence of intestinal coils from the path of the scissors. When the incision is large enough, the Surgeon inserts two fingers of his left hand into the peritoneum, and keeps them ahead of the scissors cut.

of forceps _ or between the tips of the double pair (Fig. 3325). One limb of a pair of straight, blunt scissors is now introduced into this small opening, and the incision enlarged by cutting in the median line _ introducing the left first and second fingers as a guide (formed by their palmar surface) as soon as sufficient opening has been made _ after which the peritoneal opening is enlarged to correspond with the length of the rest of the wound which should nowhere be funnel shaped, but of equal depth throughout.

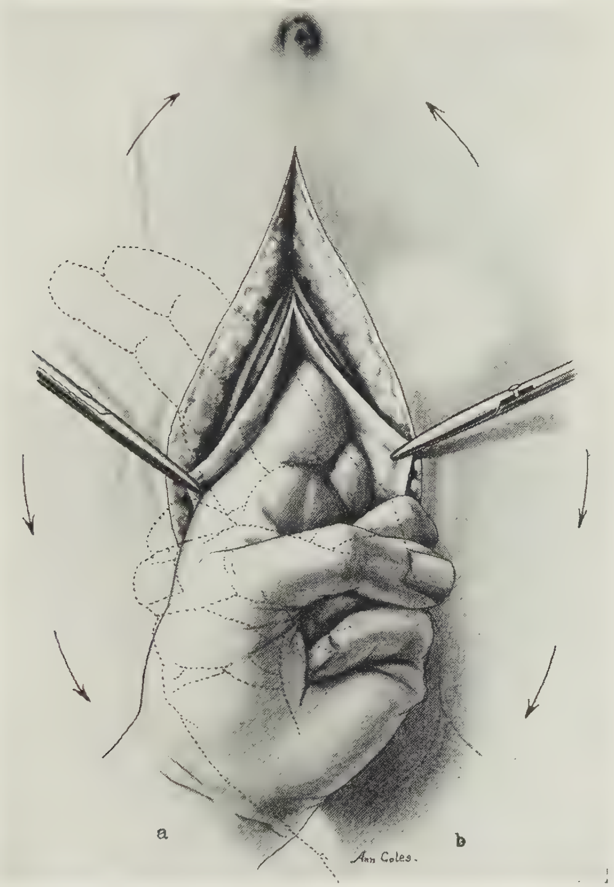


Fig. 3326.—The Same _ V; _ The introduction, into the peritoneal cavity, of the first and second fingers, of the same or opposite hands, as a guide during the progress of the intra-abdominal procedure _ or for separating adhesions _ or for safe-guarding the viscera: _ **a,** The surgeon's left hand examining the patient's left side _ and **b,** his right, the patient's right side. Or the various quadrants of the abdomen may be examined, in turn, by the surgeon's assuming different positions in connection with the same hand _ as suggested by the arrows.

Having opened the peritoneum and widely retracted the lips of the abdominal wound, the special object for which the abdominal section was made is now carried out.

Having completed the object of the operation, and prior to closing the abdominal wound, the abdominal cavity should be cleansed of all fluid by means of gauze mops or sponges _ especially in the regions of Douglas' pouch, in the female, the iliac fossæ, the renal and hepatic regions, and among the intestinal coils and recesses. Where the abdominal cavity has been extensively soiled, especially by pus, the peritoneal cavity was formerly very generally flushed — but unless it is certain that pus cannot be more generally diffused, thereby, than is already the case the local wiping away of such pus with gauze-mops is a better practice.

Having cleansed the cavity, stopped all bleeding by ligature, and counted all instruments and sponges, or pads, used in the operation, the abdomen is ready for closure. Several methods of suturing the lips of the wound are in use. Preceding the adoption of any particular method, the underlying intestines and viscera are protected and held out of the way by a broad pad of absorbable gauze. This pad also absorbs any suture bleeding which may occur, and remains *in situ* until nearly the entire length of the deepest layer (or nearly all of the single layer, where but one layer of sutures is used) is placed and tied (if interrupted), or tightened (if continuous) — and is then withdrawn through one end. In the majority of instances the pad is dispensed with — care being exercised not to wound the viscera, which may be largely accomplished by upward traction upon the margins of the peritoneum during suturing. Suturing in single layer, and in tiers will be described — of which the latter is preferable (except in emergencies, where speed is urgently demanded, as in the need of quickly ending an operation, and of resorting to measures to save life).

(*a*) Interrupted sutures of all layers in a single tier: — Having armed a fully curved needle, held in a needle-holder, with fairly stout silk, the sutures are passed from without into the abdominal cavity through one wound lip, and thence outward through the opposite, passing through all of the constituents of each lip, in the following manner: While the lips of the wound are held under slight tension by wound-hooks at either end, the Surgeon grasps the entire thickness of one lip between his left thumb and finger and sees that all of the component structures of that lip are brought into line at the margin of the wound, so as to be within bite of the point of the needle. This is particularly necessary in the case of the peritoneum, which is often partially separated from the rest of the abdominal wall in the subperitoneal areolar plane and is thus apt not to be included in the suture. While thus holding the lip of one side, the needle is passed from without inward, passing through all the structures of the lip at the same distance from their free edge and entering the abdominal cavity. The opposite lip is similarly grasped and the needle similarly passed — but from within outward, emerging at a corresponding point on the side opposite to that entered. Each of the interrupted sutures will penetrate the lips of the wound at about 0.5 cm. ($\frac{3}{16}$ inch) from their edge, and will be about 1 cm. ($\frac{3}{8}$ inch) apart. When all are placed, the free ends of the sutures on either side should be grasped and drawn upon, to see if the lips come well and evenly together. While the lips are still under tension the sutures are tied, generally beginning at one or the other end. Just prior to completing the tying, the gauze pad over the intestines, if employed, must be withdrawn. Superficial sutures may be put through the skin and connective tissue between the others, if necessary. Where much tension exists, deep relaxation sutures, placed about 1.2 cm. ($\frac{1}{2}$ inch) from the lips of the wound, and about 2 cm. ($\frac{3}{4}$ inch) apart, may be placed. Chromic gut may be similarly used. Silkworm filament may be used, but requires especial care in tying the knot.

(*b*) Tier-suturing: — First tier — consists of peritoneum — and its chief object is to shut off the peritoneal cavity. In the lower quarter of the abdominal wall, the peritoneal suture usually also includes the subserous areolar tissue (immediately outside of it) and the transversalis fascia (overlying the subserous tissue and alone forming the posterior layer of the rectal sheath) —

all within the same passage of suture. In the upper three-fourths of the abdominal wall, the following structures intervene between the peritoneum and the recti muscles, from within outward, _ subserous areolar tissue, transversalis fascia, and inner lamella of the internal oblique _ the posterior layer of the rectal sheath being formed by the aponeurosis of the transversalis and inner lamella of the internal oblique. As a rule, all structures which intervene between the free peritoneal cavity and the muscle substance of the recti are included in the peritoneal suture. Sometimes some of these structures are so well developed that they may be better sutured as a separate layer _ especially the posterior layer of the rectal sheath in the upper part of the abdomen. On the other hand, the peritoneum may be so frail, even including the subserous areolar tissue and transversalis fascia, that it is better to include all three of these in the peritoneal stitch. This first tier of peritoneal suturing is usually

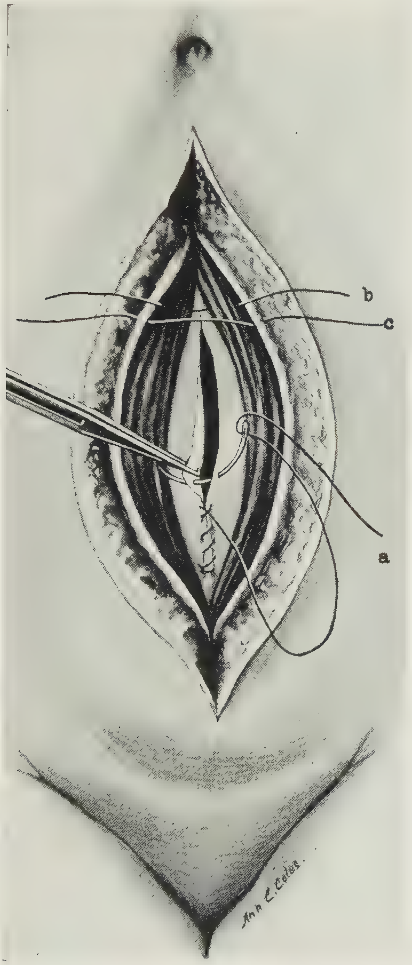


Fig. 3327.—Median Abdominal Section _ Closing the Abdomen _ I; _ Suturing the wound by the ordinary technic: _ **a**, Continuous suture of the peritoneum, subserous areolar tissue, and transversalis fascia; _ **b**, suture of the recti alone; _ or **c**, suture of opposite recti and rectal sheaths together.

made with No. 1 plain catgut _ sometimes, chromic gut, carried as a continuous suture, upon a curved needle held in a holder. The stitches should be about 3 mm. ($\frac{1}{8}$ inch) from the edge, and about 6 mm. ($\frac{1}{4}$ inch) apart. The technic is shown in Fig. 3327, **a**. Second tier _ includes the recti muscles, either exclusive or inclusive of the outer rectal sheath. In the ordinary method of suturing, the muscle and outer sheath (which is the chief strength of the abdominal wall) are included in the suture. In the overlapping method of closure (as described under the Reverdin needle technic, p. 111), the muscle alone is included in one suture _ and the outer rectal aponeurosis in another. And in the ordinary method of suturing, the rectal muscles are often sutured together _ and the rectal sheaths separately. Where the aponeurosis is included, the second tier is the chief suture for strength. The suture material is chromic catgut _ No. 1, for light abdominal walls _ and No. 2, for heavy _

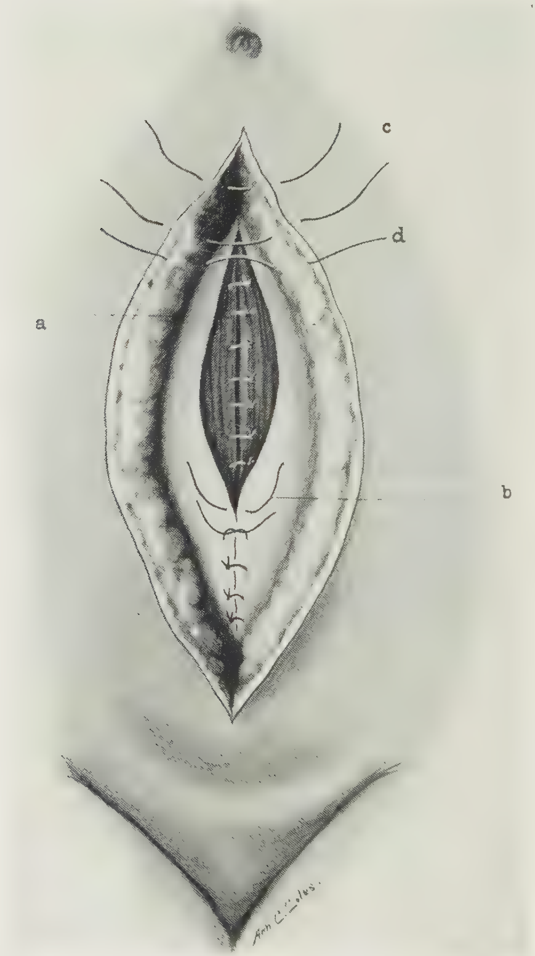


Fig. 3328.—The Same _ II; _ Suture of the wound: _ **a**, Interrupted sutures of the recti, tied; _ **b**, edge-to-edge interrupted suturing of the rectal sheath; _ **c**, interrupted sutures of the skin and superficial fascia; _ **d**, separate suture of fascia.

introduced upon a curved needle _ and are best placed as interrupted stitches _ piercing the muscle about 3 mm. ($\frac{1}{8}$ inch) from the edge, and about 6 mm. ($\frac{1}{4}$ inch) apart _ or at somewhat greater distances. In Fig. 3328, **a** the muscle is shown separately sutured _ and, at **b**, the rectal sheath also separately sutured. Third tier _ usually includes the subcutaneous areolar tissue, that is, all the fascia between the rectal sheath and the skin _ and its chief function is to obliterate dead space. The sutures are of plain or chromic catgut _ usually the former _ placed about 1 to 1.3 cm. ($\frac{1}{3}$–$\frac{1}{2}$ inch) apart, and carried upon a curved needle. Such a suture is shown at **d**, Fig. 3328. Where the abdominal wall is quite thin, the superficial fascia and skin are often included in the one tier of suturing _ as shown at **c**, Fig. 3328. Fourth tier _ includes the skin, or a thin layer of superficial fascia and the skin _ its chief use being to shut off the wound from outside contamination, as well as to close the opening, as the final act of the operation. This layer may consist of interrupted

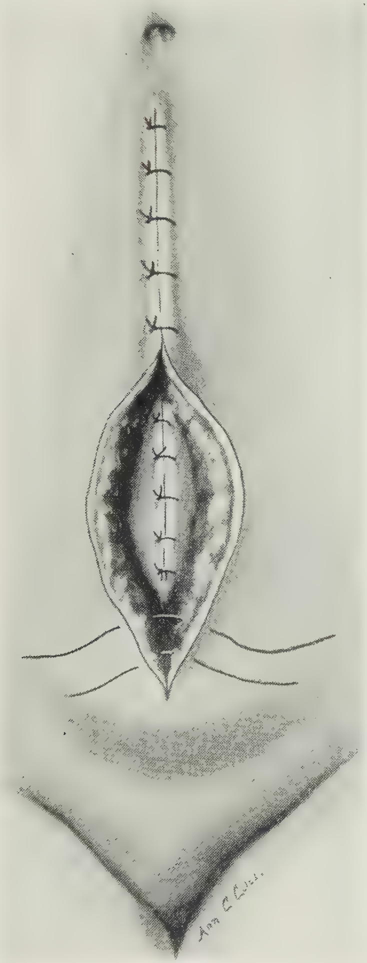


Fig. 3329.—The Same _ III; _ Suture of the wound, _ the margins of the rectal aponeurosis are united by interrupted sutures _ and the skin and fascia are being similarly sutured.

sutures entering the skin about 3 mm. ($\frac{1}{8}$ inch) from its margin, and about 6 mm. ($\frac{1}{4}$ inch) apart _ or slightly further _ the suture material consisting of silkworm filament, of silk, carried upon a curved needle, held in a holder _ or in a long Keith-needle, held in the fingers. In Fig. 3329 some of the sutures are shown placed _ and some tied. The knots are always drawn to one side, away from the line of union. Fine catgut is sometimes used _ and allowed to become absorbed. Abscess in the tract of skin sutures is common _ and, for that reason, and to prevent stitch scars, the subcuticular or chorionic suture is often used. It is placed by carrying fine silk, upon a long, straight Keith needle, through the tough chorionic layer of the skin _ only appearing upon the surface of the skin at the two knotted ends. A curved needle may also be used.

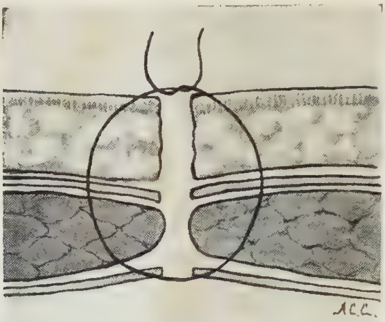


Fig. 3330.—SECTIONAL VIEWS OF SUTURING THE MEDIAN ABDOMINAL WOUND _ I; _ Single-tier suture of peritoneum, rectal aponeurosis, fascia, and skin. Secondary structures are omitted.

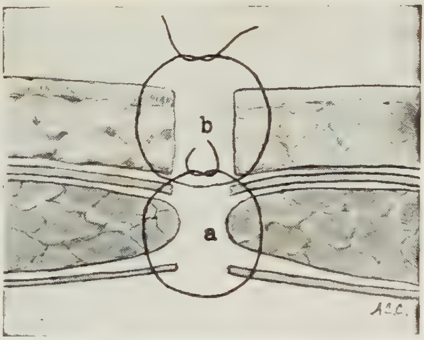


Fig. 3331.—The Same _ II; _ Two-tier suturing of the median abdominal wall: _ **a**, Suture of the peritoneum, recti, and aponeurosis of the recti; _ **b**, suture of the fascia and skin.

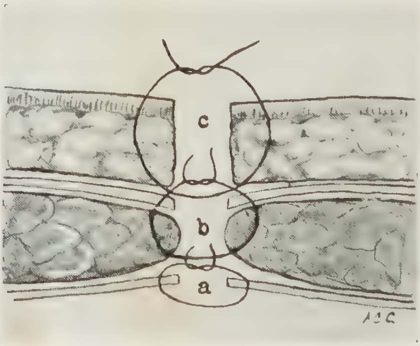


Fig. 3332.—The Same _ III; _ Three-tier suturing of the divided structures: _ **a**, Suture of the peritoneum; _ **b**, of the recti, and their aponeurotic sheath; _ **c**, of the fascia and skin.

A sectional view of suturing in a single tier is shown in Fig. 3330, of suturing in two tiers, in Fig. 3331, and of suturing in three tiers, in Fig. 3332. Surface view of suturing in four tiers is seen in Fig. 3333.

To summarize, _ light abdominal walls may be sutured, by the ordinary method, in the following tiers: _ First, of peritoneum, subserous areolar tissue, transversalis fascia; _ Second, of recti and aponeuroses (outer rectal sheath); _ Third, of superficial fascia and skin. The following tiers may be employed in heavy abdominal walls: _ First, of peritoneum; _ Second, subserous areolar tissue, transversalis fascia, inner rectal sheath (where this exists); _ Third, rectus and outer sheath; _ Fourth, fascia between rectal sheath and skin; _ Fifth, skin.

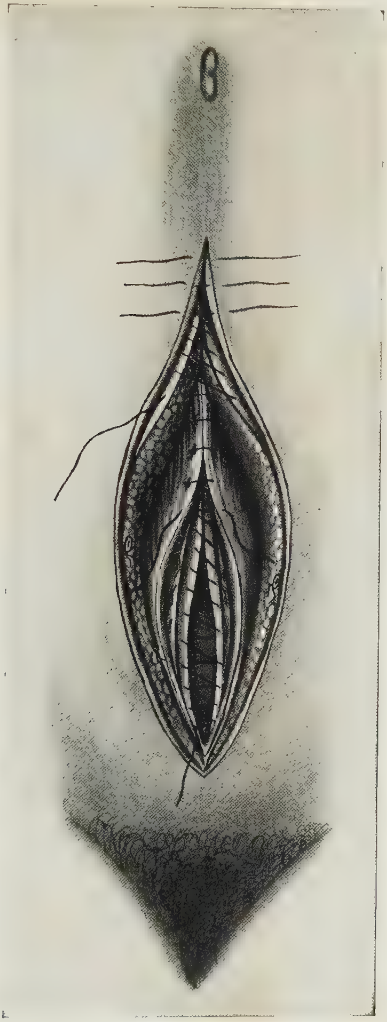


Fig. 3333.—Tier Suturing of the Wound Following Median Abdominal Section Seen in All Its Layers; _ Continuous suture approximating edges of peritoneum; _ interrupted sutures bringing together subserous areolar tissue, transversalis fascia, borders of recti muscles, and aponeuroses of the recti; _ continuous suture of superficial fascia, especially where this is thick; _ interrupted sutures of the skin.

The overlap method of suturing, which is preferable _ especially in heavy abdomens _ will be described below (p. 111).

In closing the abdomen no drainage is employed in non-infected cases. The question of drainage will be considered under the surgical treatment of suppurative peritonitis (v. Index).

Several layers of flat gauze are placed over the wound and are held in place by broad strips of zinc-oxid plaster _ which should extend far enough into each flank to give the abdominal wall substantial support. There is a tendency to omit encircling binders, to further support the wound and the dressing _ but which, in spite of this tendency, should be employed. No one will deny the sense of support _ and the actual support of a good, broad belt, snugly applied _ and the more is such a support desirable in an abdomen whose integrity has been impaired _ and in which the wound has often been forced open, even to evisceration, in the violent efforts of vomiting and of restless tossing following operation.

Complications Occurring During Abdominal Section.—(A) **Adhesions;** _ (1) Adhesions of the intestines, viscera, or omentum with each other, or with the parietal wall, may be encountered. (2) When, in the presence of adhesions, there is doubt as to whether the peritoneal cavity has been reached, pick up and roll the tissues between the finger-tips, thus judging of their nature. (3) The general principle to be adopted in the management of adhesions is to find the plane of cleavage in the abnormal union _ and, following it up, separate it as carefully as possible by fingers or blunt dissection. Where this is impossible, areas, dependent upon their nature, have to be ligated or clamped and cut, with the sacrifice of some portion of the least important structure. Ligatures are best made with plain gut for small adhesions, and chromic gut for large adhesions. While slighter adhesions may be mechanically separated, denser ones are to be clamped or ligated, *en masse* or piecemeal, and cut. (4) Intestinal Adhesions: Thin membranous adhesions may be stripped apart. Dense, organized adhesions must be separated by careful dissection, requiring especial care, as no part of the entire thickness of the adhesion can be taken from the one and left as a patch on the other, as may be done in some adhesions in other localities. (5) Omental Adhesions: These must be stripped off, or ligated and excised. The entire omentum may be ligated and excised, if necessary. Omental adhesions are ligated on their proximal side _ by pushing forceps through the free spaces and drawing back the gut ligature and tying _ and repeating the step, always tying over the free edge left by the preceding ligature. See Omentum. (6) Visceral Adhesions: Where separation cannot be accomplished _ and where the step is possible, a layer, or the entire thickness of the less important structure, is left attached to the more important one _ after ligaturing and blunt dissection or incision. The serous covering of the viscera should be preserved wherever possible _ thereby aiding in the preservation of nutrition and the avoidance of adhesions and sloughing. Such denuded surfaces may have omental grafts applied. (See Omentum.) In the median abdominal section it is to be remembered that an adherent bladder, though empty, may not be able to descend out of the way of the incision, _ and thereby may not escape injury unless specially guarded. For further consideration of adhesions, see the Peritoneum. (B) **Hemorrhage:** _ Tie, where possible, all vessels prior to their division, or immediately afterward _ as encountered in the steps of the operation after entering the abdominal cavity. Vessels which have been cut without recognition, should be immediately clamped and then tied. In the abdominal incision, prior to entering the cavity, the vessels are clamped as cut and tied before opening the peritoneal cavity. Gauze pressure and hot douching often control bleeding from indefinite sources. (C) **Irrigation:** _ Unless the abdominal cavity be very, extensively contaminated or soiled, or unless much hemorrhage have occurred, irrigation is generally not indicated. If indicated, hot normal salt solution is used. Localized infection can often be treated by localized flushing and wiping _ general infection by general flushing and drying with gauze mops. (D) **Drainage**: _ Not indicated in uncomplicated cases. Indicated in (*a*) Localized and general infection (in the former, generally _ in the latter always), _ (*b*) After intestinal or hollow visceral suturing, where there is uncertainty of efficiency of the suturing or integrity of the intestine or viscus, _ (*c*) In persistent hemorrhage. Nature of drainage materials, _ gauze, rubber tubing, glass tubing, cigarette and cigar drains. Where drainage is used, the wound should have the suturing placed throughout, and just as though the entire wound were to be closed _ and those at first left untied for the passage of the drain, should be tightened and tied when all occasion for drainage has ceased.

Comment.—Much of the ease of manipulation during abdominal section will depend upon the exposure of the field _ and this, in turn, will largely depend upon the position of the patient, in connection with the special object sought _ and upon the retraction of the structures which go to make up the field. The three most frequently employed positions, varied at different stages of the operation, are _ the horizontal, the Trendelenburg (head down), and the reversed Trendelenburg (feet down). The oblique positions allow some or all (according to circumstances) of the embarrassing structures to gravitate away from the special object of the operation. When all that is possible has been accomplished by posture, the rest of the exposure is usually secured by either retraction, of packing with large taped and anchored gauze pads _ or by both combined. Many forms of individual, and of complex manual and automatic retractors have been devised, for not only holding the boundaries of the wound apart, but for also holding away the deeper intra-abdominal structures. Several useful forms of retractors are illustrated in Figs. 3334–3338.

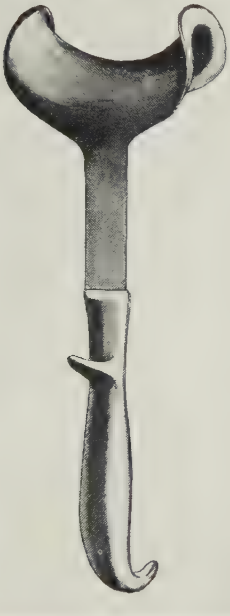


Fig. 3334.—Doyen's Abdominal Retractor.

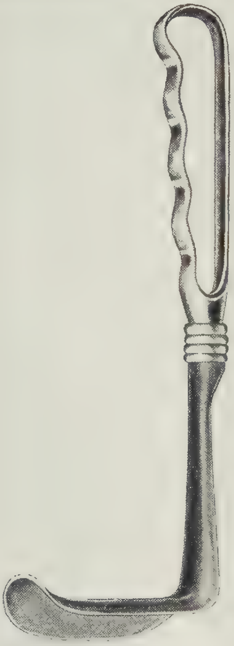


Fig. 3335.—Kelly's Abdominal Retractor.

It is not unusual to cut directly through the peritoneum into the intestine _ but it is unusual to encounter this mishap except as the result of carelessness _ and is most apt to happen when an Operator undertakes, for demonstration, or otherwise, to enter the peritoneal cavity in the minimum time after making the skin incision. In other instances it is exceedingly hard to avoid wounding the intestine, simultaneously with cutting through the peritoneum _ as, for instance, where the two are adherent. In such an event it is of the first importance not to relax the forceps from their original grips _ (Fig. 3339), but to continue to hold the intestinal opening uppermost (that leakage may be least), while the peritoneal incision is quickly lengthened _ after which the wound of the intestine is seized with forceps of the hemorrhoidal type in such a way as to exclude the rest of the tract. The peritoneum is now promptly incised to the limit of the wound _ the coil of intestine drawn out, and surrounded with gauze _ cleansed, sutured, and returned.

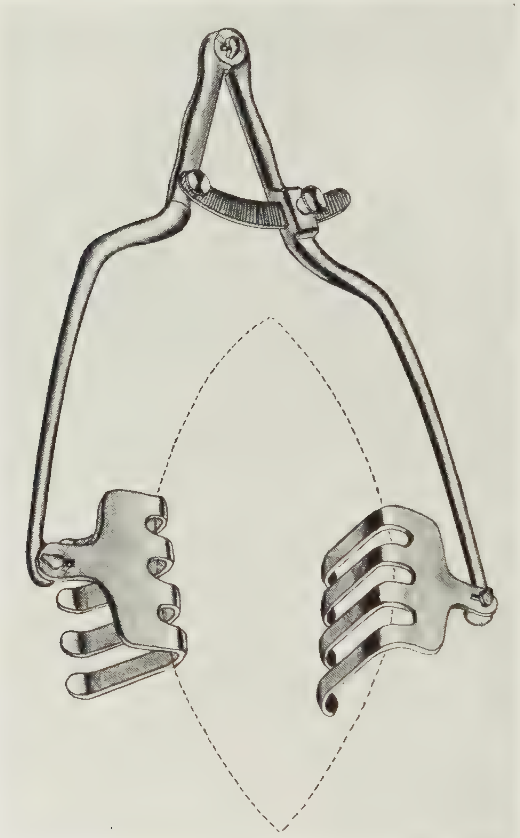


Fig. 3336.—Kelly's Automatic Abdominal Retractor _ the dotted line representing a wound, whose lips it is separating.

Even when sutures are properly placed, as to the tissues through which they pass, and the sites at which they pass, do they invariably, on tightening, draw the various structures into the desired exact relationship. The extent to which

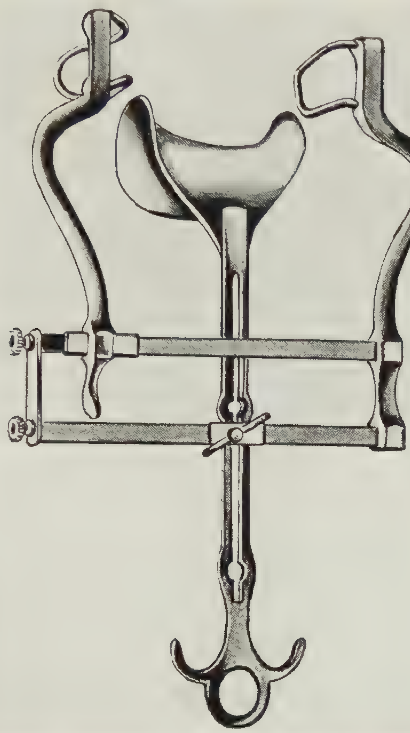


Fig. 3337.—Balfour's Automatic Abdominal Retractor.

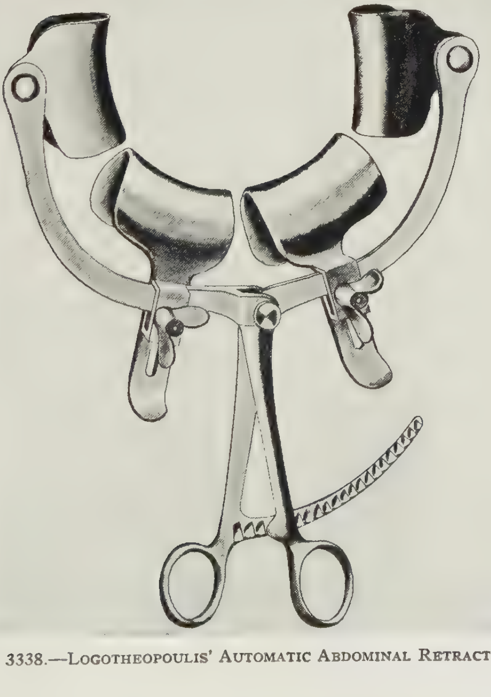


Fig. 3338.—Logotheopoulis' Automatic Abdominal Retractor.

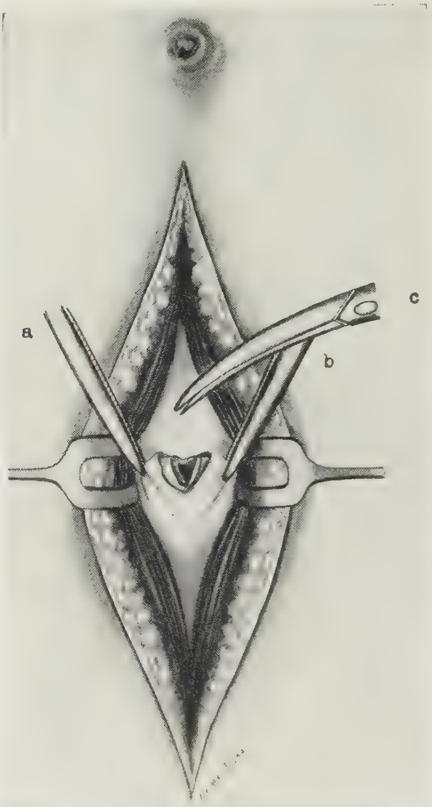


Fig. 3339.—Cutting Into the Intestine by Error in Opening the Peritoneum; — The clamps, **a** and **b**, in grasping the transverse ridge of the peritoneum, preliminarily to incision, have also accidentally included the intestine on both sides — so that the incision with the scissors, **c**, passes directly through both peritoneum and intestine, into the lumen of the latter.

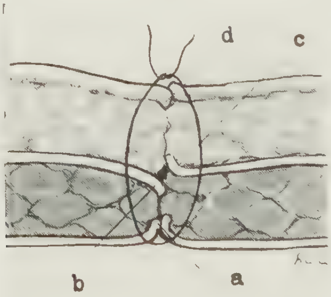


Fig. 3340.—Sectional View of Careless Suturing of the Median Abdominal Wound: — **a**, Two edges of peritoneum incurvated upon each other, and interposed between the recti; — **b**, **c**, edges of the rectal aponeuroses not in apposition; — **b**, being interposed between the recti, and **c**, between the fascia; — **d**, skin edges overlapping

displacement of structures may occur is shown in Fig. 3340. In this instance, where a single suture embraces the entire thickness of the abdominal wall, it is conceivable how displacement of individual structures might occur _ but in all instances care should be exercised, as far as it is exercisable, to secure as accurate alignment as possible.

In order to secure broader serous surfaces for union, in closing the abdominal wound, a form of continuous, right-angle suturing has been used _ as shown in Fig. 3341.

The skin incision is sometimes closed by the continuous buttonhole stitch _ which is a rapid method of securing, in effect, the right-angle crossings of the wound by the suture, without the slowness of placing interrupted sutures _ as shown in Fig. 3342.

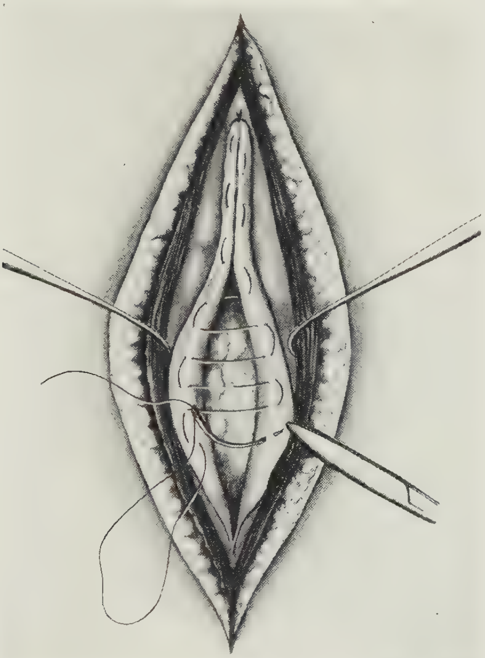


Fig. 3341.—Closing of the Peritoneum by Right-angle Continuous Suturing _ Causing eversion of margins and approximation of broader surfaces, as a means of increasing peritoneal adhesions at wound margins. The omentum here forms the background of the wound. (Modified from Kelly and Noble.)

An unusually strong type of skin suture is the lacing stitch (Fig. 3343) _ placed by threading a needle upon both ends of the suture, and advancing the stitches, simultaneously from the two sides, as one laces a shoe.

The two most important points to remember in dividing the abdominal wall are _ not to sever nerves _ and to divide muscles in their cleavage line.

As soon as the abdomen is opened, the intestines, and often other viscera, tend to force themselves through the incision _ and are best kept out of the field by packing off the region with towels counted (taped and anchored) which have been wrung out in warm normal saline solution.

Below the navel, the fascia transversalis and peritoneum should be sutured together, as a single layer _ independently of the fact that they are so adherent.

The peritoneum is usually sutured with No. 1, plain catgut _ the muscles and aponeuroses, with No. 1 or 2 chromic catgut _ and the skin, with twisted silk, or silkworm filament. Kocher uses silk for the peritoneum _ and silk, or wire of silver, or aluminum-bronze, as a permanent buried suture, for the remaining structures, up to the skin _ and silk for the skin.

The properitoneal fat should be distinguished from the peritoneum _ as should also the prevesical fatty areolar tissue.

The umbilicus is systematically excised, in the course of the median abdominal sections by some Surgeons _ except in the case of young women.

The upper end of the median abdominal incision should not extend too near to the xiphoid cartilage, for fear of wounding a low-lying pleural cavity.

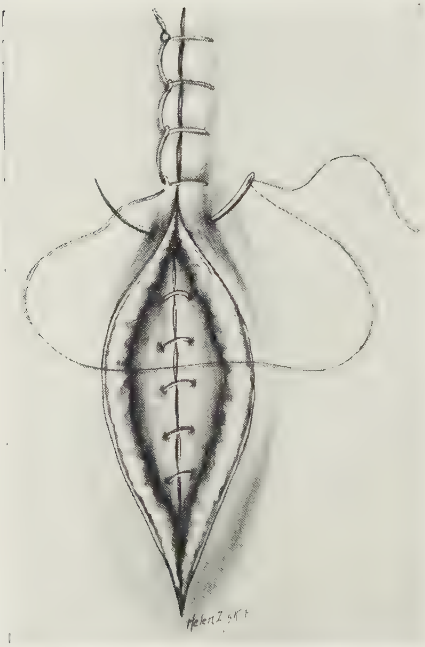


Fig. 3342.—Closure of the Aponeuroses by Ordinary Continuous Suture _ and the Skin, by Continuous Buttonhole Suture.

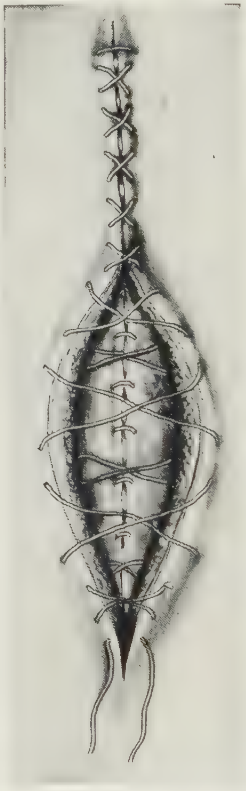


Fig. 3343.—Lacing Suture of the Skin and Fascia in Median Abdominal Section. The rectal sheath is closed by ordinary continuous suturing.

In order not to carry bacteria from the skin layer into the peritoneal cavity, some Surgeons, on completing the incision of the skin, use a second knife for the rest of the section.

Monks has determined that the upper third of the small intestines usually occupies the upper left hypochondral region _ the middle third, the central portion of the abdomen _ and the lower third, the right iliac fossa and pelvis.

Moist gauze sponging and packs are less irritating to the peritoneum than dry ones.

CLOSURE OF ABDOMINAL SECTION OF THE OVERLAP METHOD AND BY THE REVERDIN NEEDLE TECHNIC

The strongest method of repair of the opened abdominal wall is by the overlapping of the divided muscular aponeuroses _ and much the most expeditious technic of accomplishing the suturing of the severed structures, is through the use of the Reverdin needle.

The overlapping of the aponeuroses of the abdominal muscles, wherever encountered _ whether for hernia, where it is the typical procedure, or following ordinary openings of the abdominal cavity _ is the most effective means at our command to counteract the subsequent tendency to hernia.

The use of the Reverdin needle for suturing is not common in this country _ and its dextrous manipulation can only be acquired by practice, and by the co-operation of an Assistant trained in its employment _ for it is a technic in which the competent aid of the Assistant is essential _ even though he only plays the rôle of feeder of the thread to the needle. It is safe to say that two abdominal sections can be sutured by the Reverdin needle method while one is being sutured by any of the ordinary methods _ and possibly three _ that is, it is from half to two-thirds as fast again. Further, it is equally safe to say that the Surgeon who has taken the trouble to acquire the technic, is not apt to abandon it for any of the ordinary methods. The writer's familiarity with its use is the result of extensive association with that Master Surgeon, Matas _ whose skilful and rapid employment of the Reverdin needle, as the first means of suturing almost all structures lying below the skin level, is impressive, and a temptation to its adoption.

Reverdin needles are of French origin _ and come in all varieties of sizes and curves. It is hard to conceive of any situation, or use, in which it is not applicable _ and hard to see how anything else could be used in some situations (as in some of the more intricate overlapping methods) _ as it may equally well carry the thread through both sides of a wound as it enters, and leave it _ or may go in empty, and draw the thread back with it, as it is being withdrawn from the wound. With such care as should characterize contact with all surgical instruments, its two delicate parts _ point and movable eye _ should not be injured. But if the postoperative gatherer-up of instruments is going to pitch them across the room into the first washing receptacle their use had better be abandoned. Only one person should be held responsible for their care _ and she should be taught to unscrew the delicate parts after each usage, and dry the slender shaft of the instrument which closes its eye, and the bed in which it travels _ and to keep the very sharp point capped with a cork, when not in use. A form of the instrument is also made for skin suturing _ with a particularly small shaft. Owing to the fact that the shaft of the instrument must be hollow, its diameter is necessarily greater than that of a common needle _ which is the only argument which qualifies its use for the skin, and for hollow viscera which may leak through the needle puncture _ (and which puncture the following thread might not entirely fill). Finally, the Reverdin needle is essentially a suturing instrument for speed and accuracy.

The usage of the Reverdin-needle is one of those technics difficult to describe by word _ and easy to understand by picture. The Surgeon holds the handle of the instrument in his right hand _ his thumb controlling the sliding mechanism which opens the eye of the needle (by drawing backward the button which controls the slender eye-closing rod (Fig. 3344, **a**) _ and closes it (by pushing the button forward). The Assistant, trained to the technic, stands in front of the operator, on the opposite side of the table, and acquires his own method of feeding the rapidly traveling needle _ the features being, that the thread should be taut while it is being fed to the needle (when the needle is passed through the tissues, as is usual, empty) _ and at once slightly relaxed (but not entirely slackened) after it has been locked in the eye, and the needle is being withdrawn to the Surgeon's side of the wound. A single length of thread is conveniently held as shown in Fig. 3344, **b** _ which position is acquired in less than two seconds. A bodkin of suture material may be held in the palm of the left hand _ the right hand drawing out the end to feed the needle in the manner illustrated. In the interval following the passage of the suture the Assistant's right hand is free to cut the suture. All sutures are usually passed before any are tied _ when either the Surgeon or his Assistant is free to tie them all.

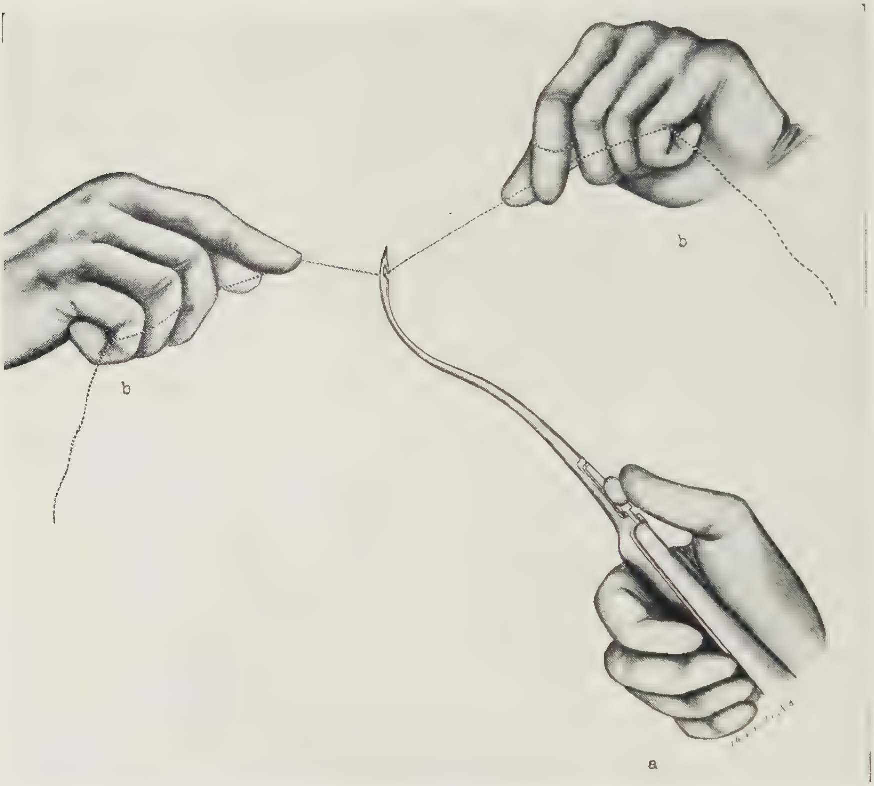


Fig. 3344.—Manipulation of the Reverdin Needle and Suture: _ **a,** Operator's grasp of the handle of the Reverdin needle, controlling the opening and closing of the needle-eye mechanism; _ **b,** Assistant's hands, standing opposite to Surgeon, rapidly feeding silk, thread, or gut suture to the needle _ whose eye will be then closed.

The usual method of procedure is for the Surgeon to grasp the lip of first one side, and then of the opposite side, with toothed forceps held in his left hand _ passing the Reverdin empty, from his side, toward the Assistant's side _ who then feeds the needle (Fig. 3345) _ after which, he holds one end of the thread, and lets go the other _ the Surgeon drawing the loop back with him (Fig. 3346) _ and the two ends are then ready to be tied.

An alternate method (of especial use in suturing in deep recesses, where forceps may have to take the place of fingers), is for the Reverdin to be fed a loop (in the manner already described) before the needle enters the wound _

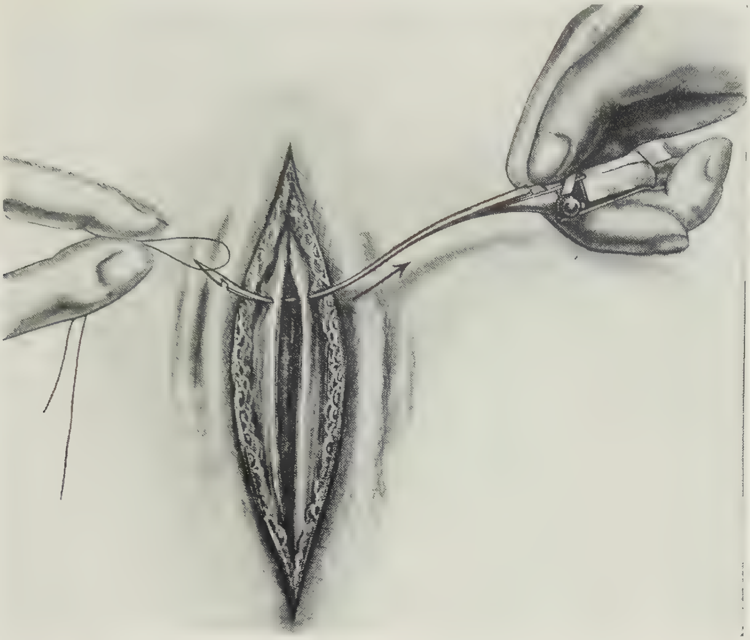


Fig 3345.—Simple, Interrupted Suturing, by the Reverdin Needle Technic – Method It – The Reverdin needle is carried forward, empty, through both lips of the wound – and, on emerging from the far side, is fed a loop of suture material by the Assistant – after which it is ready to be withdrawn backward toward the Surgeon.

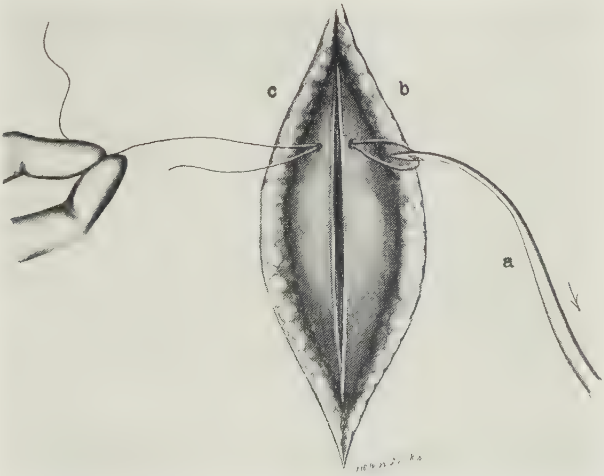


Fig. 3346.—The Same – I; – Second step; – The Reverdin needle, **a**, is thrust, empty, through the lips of the aponeurosis, from the side, **b**, to the side, **c** (v. Fig. 3345) – and is there fed a loop of thread, one end of which is held by the Assistant, while the needle is drawn backward, to the side, **b** drawing the free end of the thread with it – which is then ready to be tied to the opposite end.

after which the instrument is pushed through the two lips of the wound (Fig. 3347), carrying the loop with it – and, when the opposite side is reached, the

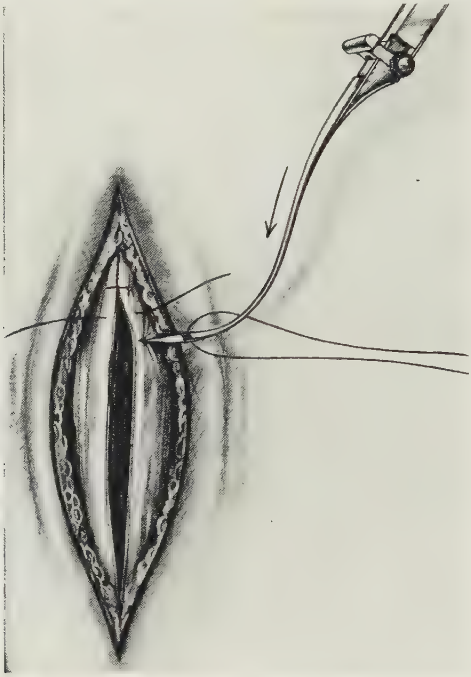


Fig. 3347.—Simple, Interrupted Suturing, by the Reverdin Needle Technic – Method II; – The Reverdin-needle has been fed a loop of suture material before starting on its journey through the two lips of the wound – from the surgeon's to the assistant's side. The loop will there be steadied with forceps while the needle is withdrawn – after which one limb of the loop will be drawn entirely through the wound. This method is less frequently employed than is the preceding one – where, after feeding the loop to the needle, the assistant retains hold of one limb of the loop, while the surgeon draws the other through the wound.

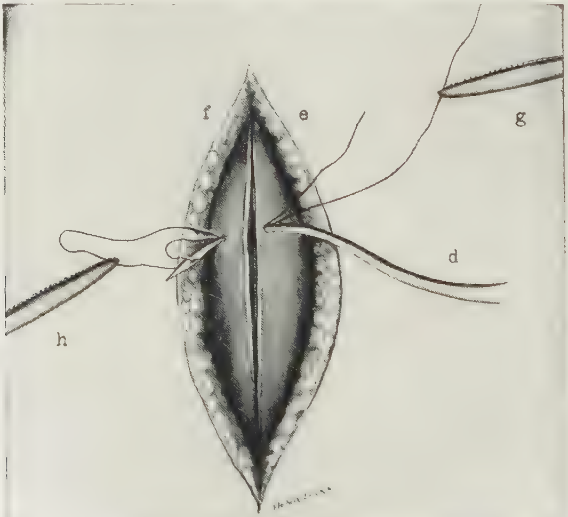


Fig. 3348.—The Same – II; – Second Step: – The Reverdin needle, **d**, is thrust, threaded, through the lips of the aponeurosis, from the side, **e**, to the side, **f**, – a clamp, **g**, holding one limb of the loop. On emergence upon the side, **f**, a clamp, **h**, grasps the loop – while the needle is withdrawn to the original side – leaving the free end in the grip of clamp, **b**. The ends are then ready to be tied together.

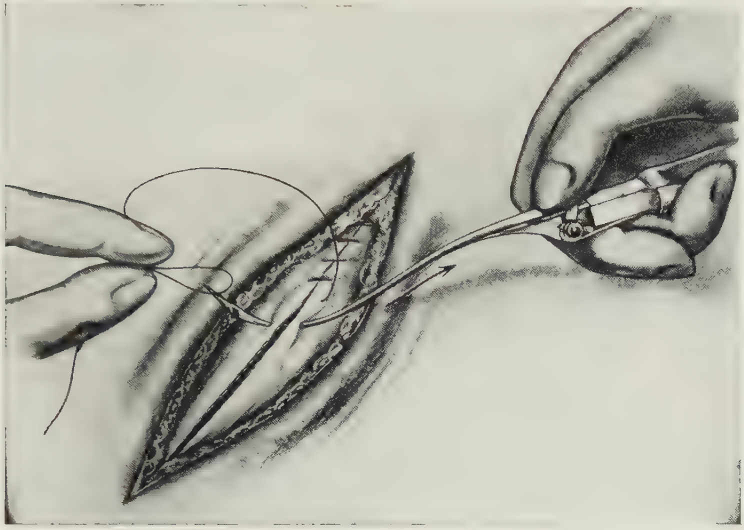


Fig. 3349.—The Application of the Ordinary Continuous Suture by the Reverdin Needle Technic; _ The empty needle _ here shown after the suturing has progressed through a few stages _ is in the act of being carried forward through both lips of the wound _ where an assistant is feeding to it a loop of the continuous suture _ which the surgeon will draw back toward himself _ thus repeating similar steps to the end of the wound.

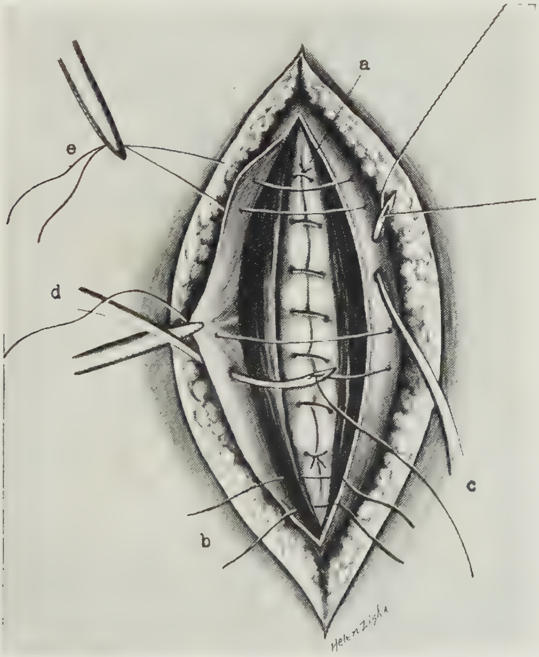


Fig. 3350.—Closure of the Abdominal Wound by the Overlapping Method with Reverdin Needle _ I: _ **a**, The peritoneum has been closed by continuous suturing; _ **b**, interrupted sutures of the muscle margins; _ **c**, first stage _ mattress-suture being placed in the overlapped rectal aponeurosis by Reverdin-needle; _ **d**, second stage _ mattress-suture being drawn through the overlapping rectal aponeurosis; _ **e**, third stage _ completed mattress-suture ready to be tied _ (the accomplishment of which is shown in Fig. 3351).

Assistant grasps the loop with forceps, and holds it while the needle is being withdrawn (Fig. 3348).

Continuous suturing can be done even more rapidly than interrupted suturing by the Reverdin method _ and much more rapidly than by the ordinary needle. The thread is drawn through the lips of the wound during the withdrawal of the needle _ as shown in Fig. 3349.

Several applications of the Reverdin technic in the overlap method of suturing will be now illustrated:

In Fig. 3350 the suturing has all been done by Reverdin _ the peritoneum, continuously _ the recti, interruptedly _ and the outer aponeuroses of the recti (the main feature of the closure, and the chief source of strength) are being overlapped, in the manner described in the legend of the picture.

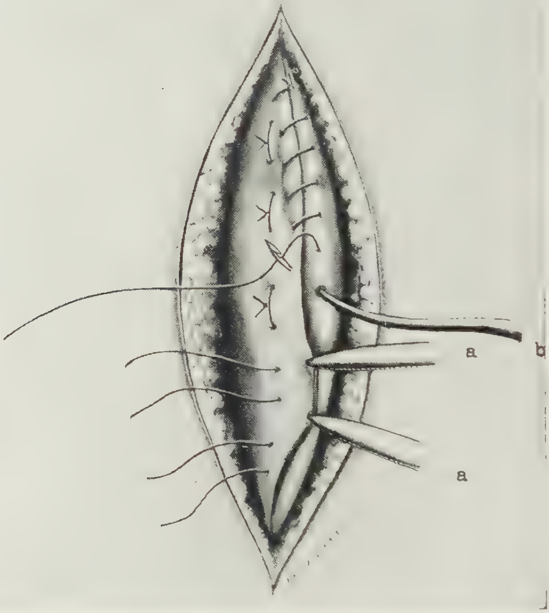


Fig. 3351.—The Same _ II: _ a, a, Clamps drawing the *overlapping* rectal aponeurosis over the ***overlapped*** rectal aponeurosis, while the knots of the mattress-suture are being tightened; b, Reverdin needle tacking down the free *margin* of the overlapping aponeurosis to the *surface* of the overlapped aponeuorsis, by continuous suturing _ (the suture should be passing through the eye of the needle). The skin is finally closed in the usual manner.

In Fig. 3351 some of the mattress-sutures of the preceding picture have been tied, and others are ready to be tied _ while the margin of the overlapping aponeurosis is being tacked down by continuous suturing to the surface of the overlapped aponeurosis (see legend).

In Fig. 3352 another method of placing the mattress-suture is shown. The margin of the overlapped aponeurosis is seized with two clamp forceps _ and the margin of the overlapping aponeurosis, with one (better, two) _ and, while the latter is being pulled over the former (and the former tucked under the latter), the mattress-suture is being placed, by a single thrust of the Reverdin, through both aponeuroses, in the axis of the wound. The margin of the overlapping will be tacked to the surface of the overlapped aponeurosis as in the last figure.

In Fig. 3353 one of the cleverest applications of the Reverdin technic is shown _ where, simultaneously, by the one stitch, both the surface and edge of the overlapping aponeurosis is sutured to the surface of the overlapped aponeurosis.

In Fig. 3354 a very complex suture, worked out by Kelly and Noble, for dove-tailing the outer border of the rectus muscle into the cleavage space between the external and internal oblique (and evidently applicable with great difficulty by ordinary needle in holder), is here shown readily introduced by Reverdin. The details of a single stitch is seen in Fig. 3354, a.

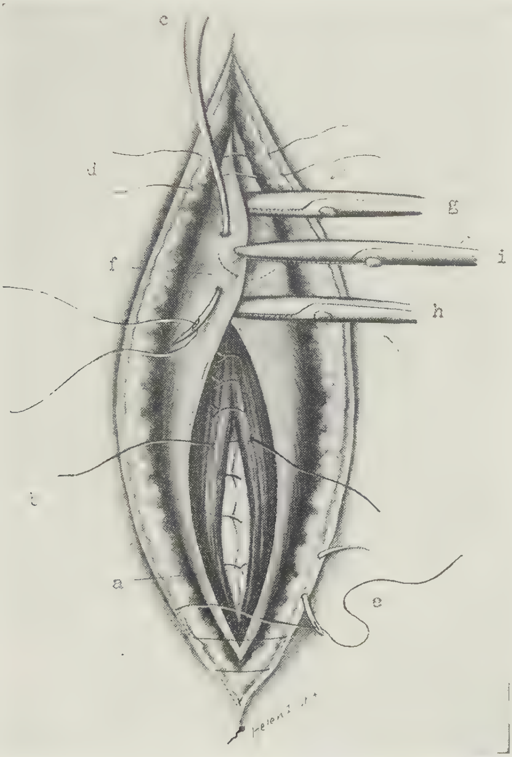


Fig. 3352.—Closure of the Median Abdominal Wound by Tier Suturing with Reverdin Needle: _ **a**, Continuous suture of peritoneum; _ **b**, interrupted suture of muscle; _ **c**, overlapping of anterior layer of rectal aponeurosis of rectus, by interrupted mattress-sutures introduced by Reverdin-needle; _ **d**, interrupted connective tissue suture; _ **e**, subcuticular (chorionic) continuous suture. The margin of the overlapping aponeurosis may be additionally tacked down, if desired, as shown at **f**. A Reverdin-needle technic different from the one shown in Fig. 3351 is here illustrated _ forceps, **g** and **h**, grasping the margin of the overlapped aponeurosis, and *pushing* it *under* the overlapping aponeuosis, which is being *pulled* in the opposite direction by the forceps, **i**.

Following the suturing of the structures beneath the skin in the manner just described, the margins of the skin may be brought together in one of several ways: _ (*a*) By the subcuticular suture _ as pictured in Fig. 266, and described in Vol. I, page 275. (*b*) By the ordinary interrupted silk-worm sutures. (*c*) By fine, twisted silk, threaded upon a Keith abdominal needle, held directly in the fingers _ the procedure being as shown in Fig. 3355.

In addition to such methods of suturing as those mentioned, the margins of the abdominal wound may be brought together largely by strips of sterile adhesive plaster _ with the occasional reinforcement of a fine marginal silk suture at rare intervals.

It may be a matter of some consequence, to the patient, in the case of a young woman, to avoid the criss-cross suture scarring which is so often left to permanently disfigure the abdominal wall. In this connection the writer, in his work with Matas, has had much contact with a technic most satisfactorily employed by him, which largely minimizes the unpleasant feature of stitch scarring. The abdominal wound, below the skin level, is closed with care and detail _ for it is upon this, anyhow, that the strength of union chiefly rests _ and then, even in a long abdominal wound, but two, sometimes three (or even one) fine silk sutures will be carried through the skin margins, after accurate approximation. Theses are tied in the usual way, but with more than the usual care, so as to accomplish an anatomic apposition _ and no more are placed. Then, between these, and as near together as may seem indicated, narrow strips of sterile zinc-oxid plaster are placed (Fig. 3356) _ by a technic only to be acquired through practice _ in which anatomic apposition is everywhere secured along the skin line. The whole wound is then covered, first, with layer gauze, and, then, with fluff gauze _ over which broader strips of ordinary zinc-oxid plaster are placed. The resulting scars

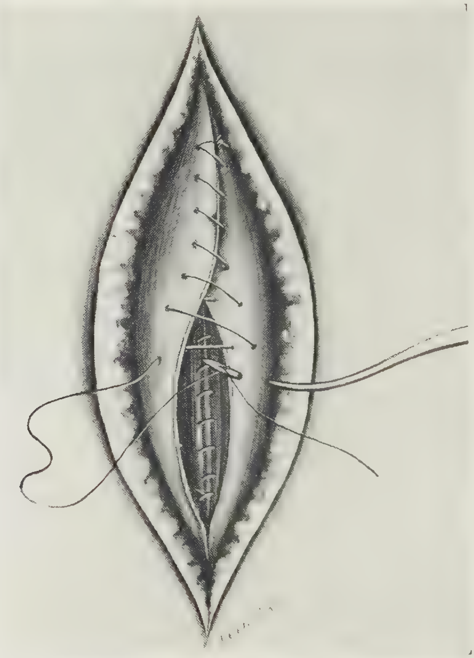


Fig. 3353.—Closure of Median Abdominal Section _ Illustrating Overlapping of the Anterior Layer of the Rectal Aponeurosis by Continuous Suturing with the Reverdin Needle; _ The muscle margins have been approximated by ordinary continuous suturing. The aponeurosis of the right side is being overlapped upon that of the right by means of a Reverdin needle _ thus approximating surfaces rather than margins.

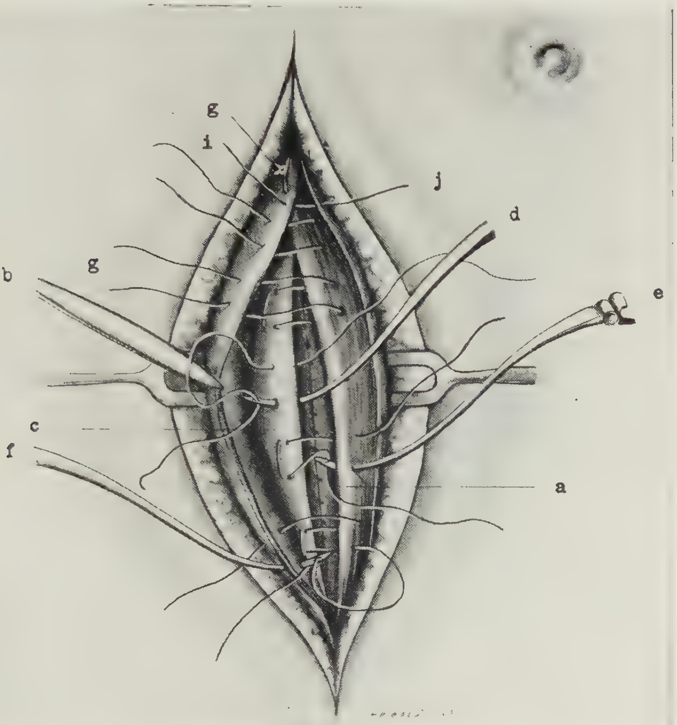


Fig. 3354.—Method of Closing the Abdominal Wall when Opened Through the Outer Third of the Rectal Sheath with Reverdin Needle; — By dove-tailing the outer margin of the rectus, **a**, into the cleavage space between the external oblique, **b**, and internal oblique, **c**; — **d**, passage of the first stage of the mattress-suture by Reverdin needle; — **e**, passage of the second stage; — **f**, passage of the third stage. Completed mattress-suture is shown at **g** (near center) — and tied mattress-suture at **g** (at upper part of picture). The peritoneum has been closed by continuous suture. The free edges of the rectal aponeurosis, **i** and **j**, are united by interrupted or continuous suture. (Sectional view of the mattress-suture is shown in Fig. 3354.) (Modified from Kelly and Noble as to anatomy.)

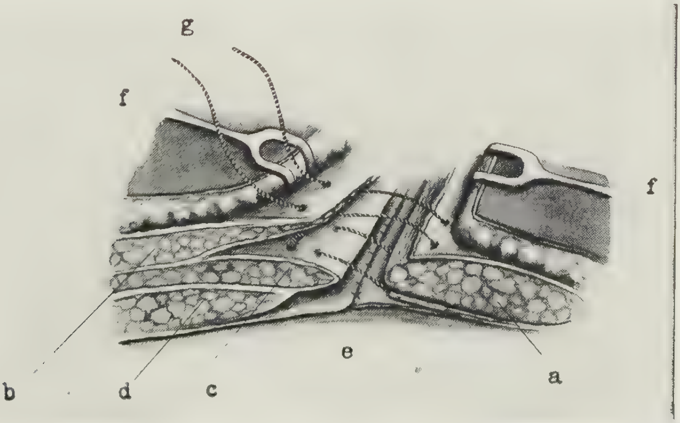


Fig. 3354a.—The Details of the Mattress-suture Shown in the Preceding Picture: — **a**, Rectus, with its aponeurosis above and below, but split at its margin; — **b**, external oblique; — **c**, internal oblique; — **d**, transversalis; — **e**, peritoneum closed by continuous suture; — **f**, **f**, skin and connective tissue, — **g**, one complete mattress-suture. (Modified from Kelly and Noble.)

are often but slightly noticeable _ and are almost invariably much less so than they are by other methods.

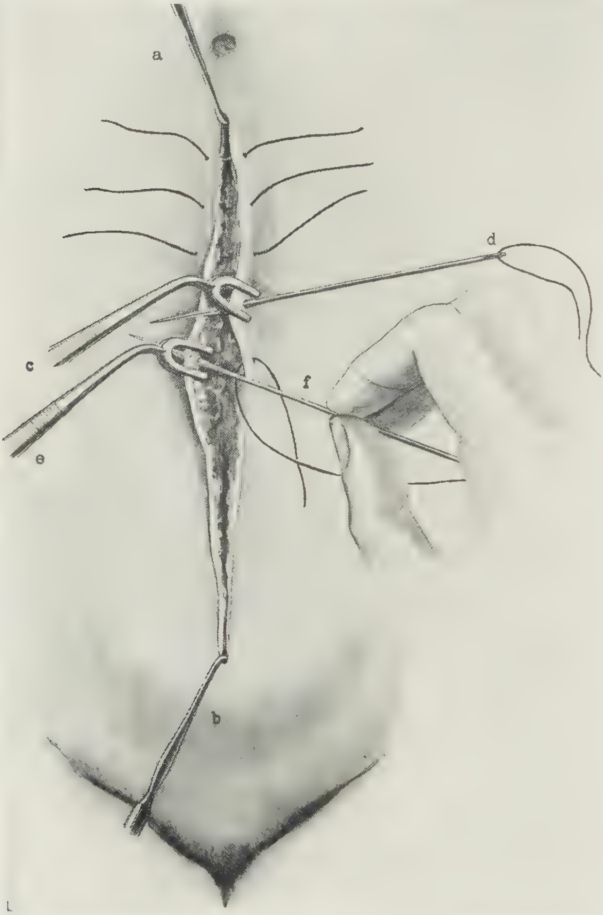


Fig. 3355.—Method of Uniting the Wound Margins, in Abdominal Section, by Hand-held, Long Needle _ Aided by Wound-hooks and Skin-suturing Forceps: _ **a, b,** Wound-hooks in the act of paralleling the borders of the wound, and tensing or relaxing them, as indicated; _ **c,** Roubaix suture-forceps, steadying the nearer border of the wound, while a Keith needle, held by the fingers, **f,** is in the act of being carried through the margin, from without, inward; _ **e,** the forceps are then shifted to the further lip of the wound, which it steadies, while the needle is carried through, now from within, outward, **f.**

Subcuticular suturing of the skin margins also minimizes scarring _ but is more difficult, uncertain, and time-taking than the method just mentioned.

Michel's clamps are sometimes employed in bringing together the skin margins _ though less frequently than formerly.

Many novel methods of approximating the cutaneocellular edges of the abdominal wound are seen from time to time in hospital rounds _ but few, however, presenting outstanding advantages.

The support of an overlying abdominal binder, though not so generally used at present, substantially steadies the abdominal margins during healing.

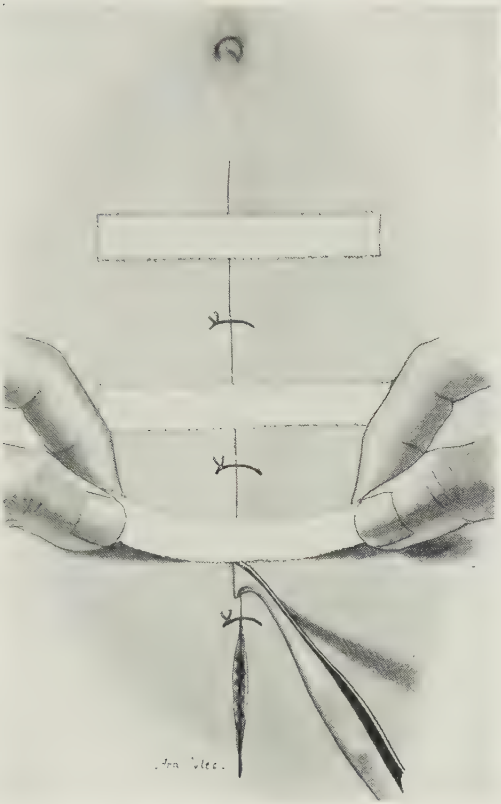


Fig. 3356.—Method of Uniting the Wound Margins, in Abdominal Section, by Two or Three Skin Sutures, and Narrow, Intervening Strips of Sterile, Zinc-oxid Plaster; _ Following the one or more sutures, the edges of skin intervening between the sutures are accurately ridged-up, between the forefinger and thumb _ or by special skin-suturing forceps _ until epithelium is approximated to epithelium, with nicety and accuracy _ after which ½-inch strips of sterile zinc-oxid plaster are placed across the wound at intervals _ and with such carefully adjusted tension upon the parts that the margins will, upon relaxation of the finger pressure, assume a horizontal level of easy and accurate marginal approximation.

ANTEROLATERAL ABDOMINAL SECTION

BY McBURNEY'S INTRAMUSCULAR ("GRIDIRON") INCISION

Description.—Having divided skin and fascia, the various musculo-aponeurotic planes of the abdominal wall are divided in the order encountered and in a line with the muscular and tendinous fibers composing those planes_ thus avoiding the division of any important nerves; the transverse division of any of the component muscular fibers; the retraction of transversely cut muscular and tendinous fibers_and, therefore, avoiding the consequent paralysis of parts supplied by severed nerves, and weakening of cut muscles.

While McBurney's operation is chiefly applicable to the anterolateral abdominal region (where the external and internal oblique and the transversalis muscles are all present), the principle of intramuscular separation should be applied to all sites of the abdominal wall where it is possible to do so. The operation is principally resorted to for the removal of the appendix vermiformis, especially in the quiescent stage of appendicitis.

Preparation.—Site of incision to be shaved.

Position.—As in Median Abdominal Section.

Landmarks.—Where the operation is done in connection with Appendicectomy, McBurney's point is located, which is a point on an imaginary line extending from the anterior superior iliac spine to the umbilicus, at a distance of 3.8 cm. (1½ inches) internal to the anterior superior iliac spine.

Incision.—In cases of Appendicectomy the incision commences about 2.5 cm. (1 inch) above the imaginary line just mentioned, and passes obliquely downward and inward in the direction of the fibers of the external oblique muscle and aponeurosis _ crossing the above line at McBurney's point _ and ending about the same distance below as above it. The length of the incision may be greater or less than the above, according to the space required. A free skin incision greatly aids the muscular retraction. (See Fig. 3321, E.)

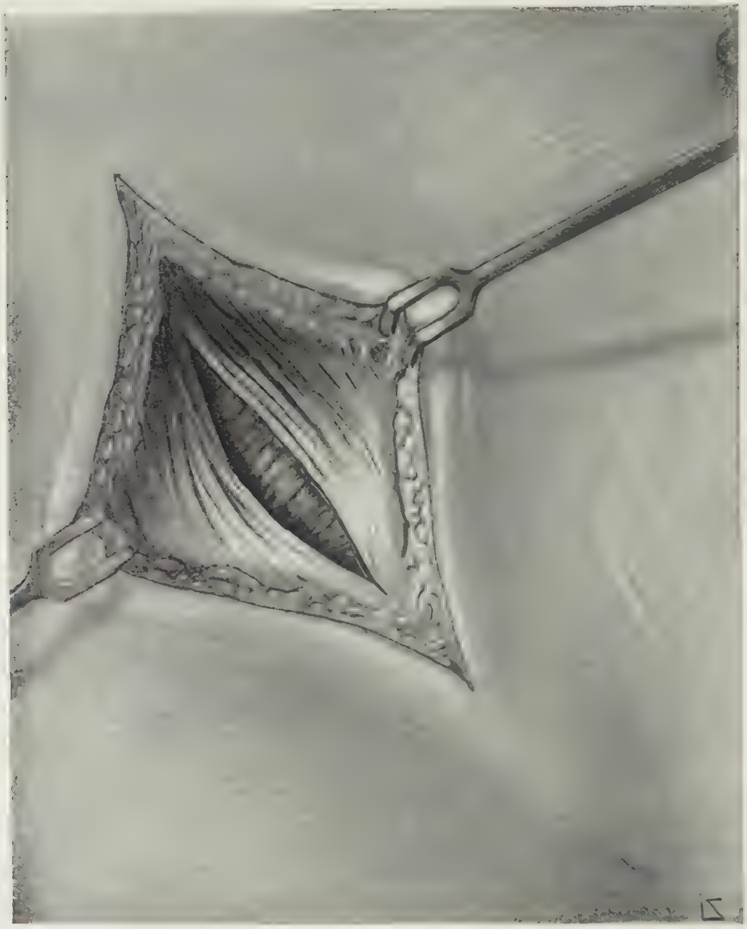


Fig. 3357.—McBurney's Intramuscular, Anterolateral Abdominal Section _ I; _ The skin and fascia have been divided and retracted _ the fibers of the aponeurotic and muscular portions of the external oblique split in their cleavage line running downward and inward _ and, through their separated margins, the fibers of the internal oblique are seen, passing upward and inward.

Operation.—Having incised the skin and fascia in the above line (which will correspond with the cleavage line of the skin), and having controlled hemorrhage and retracted the lips of the wound, the muscular and tendinous fibers of the external oblique will be exposed (Fig. 3357). Incise the external oblique, with a sharp scalpel, directly in a line with its muscular fibers above, and their tendinous continuation in the aponeurosis below – continuing the separation with scalpel or scissors, incising between the fibers without severing them. The two lips of the incised external oblique are drawn respectively upward and inward, and downward and outward – thus exposing the intermuscular fascia between external and internal oblique.

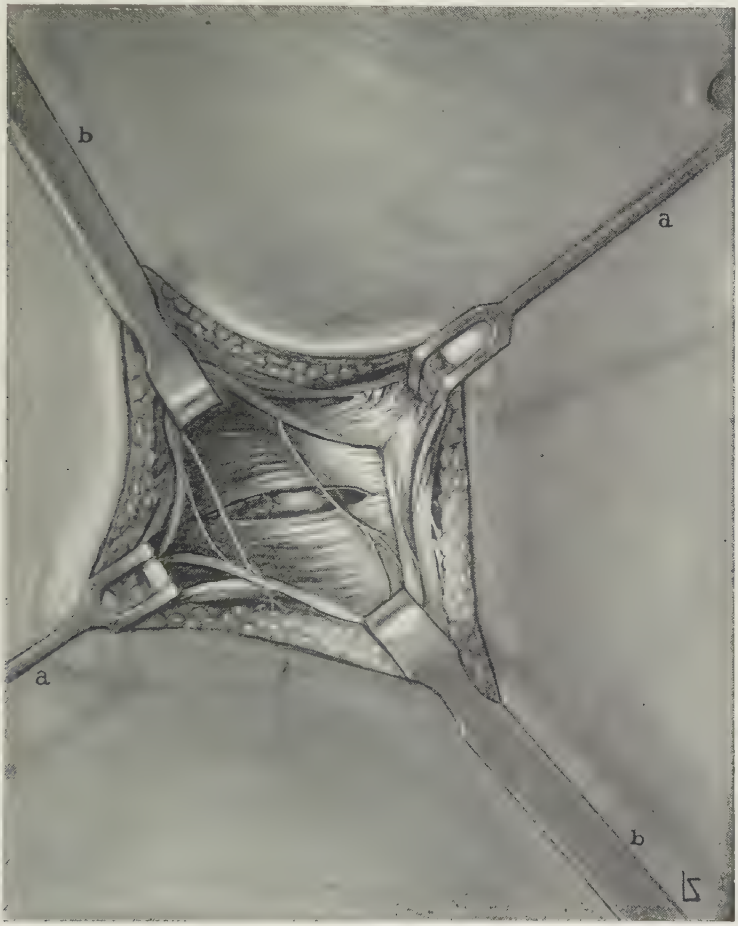


Fig. 3358.—The Same – II: – **a, a,** Retractors of the split borders of the external oblique, shown in the preceding picture; – **b, b,** retractors of the split borders of the internal oblique, passing upward and inward (the lowermost fibers of this muscle, however, passing inward and downward). Beneath the internal oblique the split transversalis muscle is exposed, the fibers of which are passing transversely – and, beneath the split transversalis, the transversalis fascia and peritoneum are seen. Branches of the eleventh and twelfth nerves are shown, coursing downward and inward, between the internal oblique and transversalis.

The sheath and fibers of the internal oblique (the muscle being here quite thick) are now similarly separated by scalpel, scissors, or blunt dissection, in the line of their cleavage (which is nearly at a right angle to the cleavage line of the fibers of the external oblique), the center of the separation of the fibers being about opposite the anterior superior iliac spine (Fig. 3358). The lips of the internal oblique are now retracted respectively upward and outward, and downward and inward – thus exposing the intermuscular fascia between internal oblique and transversalis. Guard with especial care all nerves lying in this intermuscular plane.

The fibers of the transversalis, which, for practical purposes, run very nearly in the same direction as those of the internal oblique, are now similarly separated in their cleavage line (Fig. 3359). The lips of the transversalis may be separately retracted upward and downward, but are generally included in the grasp of the same retractors which retract the internal oblique. The transversalis fascia at the bottom of the wound is thus exposed for an inch or more.

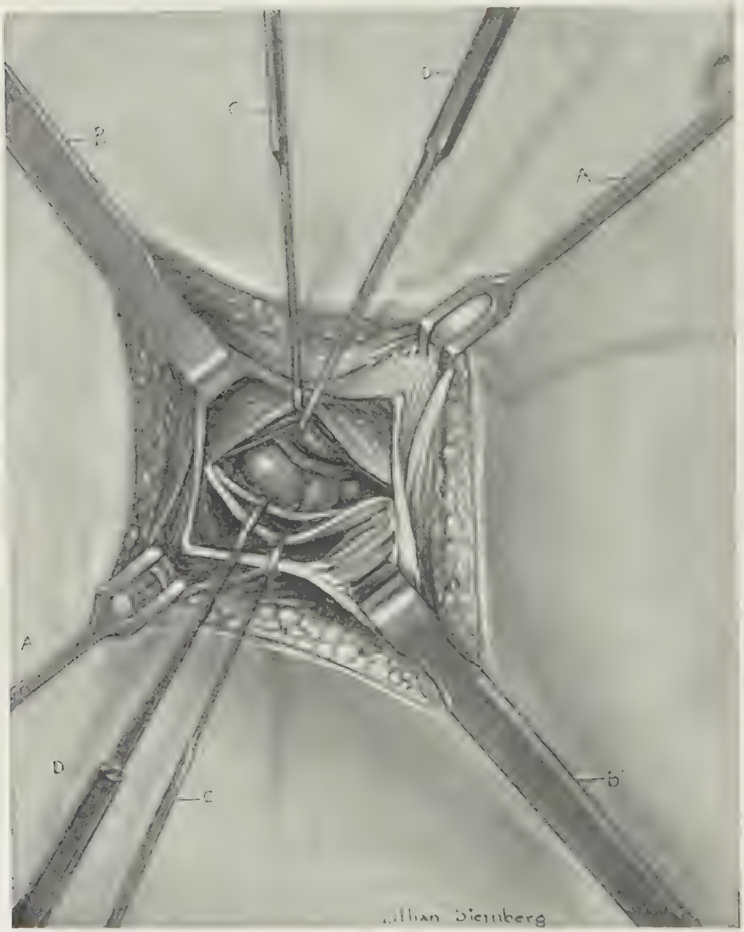


Fig. 3359.—The Same – III: – A, A, The split margins of the external oblique retracted; – B, B, the split borders of the internal oblique retracted; – C, C, the split borders of the transversalis retracted; – D, D, the retracted edges of the divided transversalis fascia and peritoneum – exposing the cecum in the depths of wound.

The transversalis fascia is grasped with forceps and divided in the line of the transversalis muscle (transversely) – when the subserous areolar tissue and peritoneum will be exposed. The peritoneum is grasped with two toothed forceps, manipulated as in the median abdominal section, and divided with scissors to a limited and guarded extent. One blade of the scissors is then carefully introduced within the abdominal cavity and the opening enlarged toward the median line and the anterior superior iliac spine. The subperitoneal areolar tissue, transversalis fascia, and peritoneum may be simultaneously incised _ but it is better to incise down to and recognize the peritoneum, and then incise the peritoneum separately and alone.

The special object of the operation is now accomplished. The wound is then ready for closure. Separate continuous suturing of the following layers with catgut is made: _ (*a*) peritoneum, subserous areolar tissue, and transversalis fascia _ (*b*) transversalis _ (*c*) internal oblique _ (*d*) external oblique _ (*e*) subcutaneous fascia, especially where thick _ (*f*) and the skin is closed by subcuticular silk suture or interrupted silkworm-gut. The subcutaneous areolar tissue and skin are often included in one tier, where interrupted suturing of these two structures is done. All parts are thus brought together along their original cleavage lines and accurately approximated.

Comment.—But small part of the muscular portion of the external oblique is exposed. The twelfth intercostal nerve, and, when the incision is long, the iliohypogastric nerve are in danger (as they run somewhat more transversely than the fibers of the external oblique) and should be retracted out of danger. This is the best method of entering the abdominal cavity, at this site, in indicated cases _ as, for example, the removal of the appendix between attacks. It is not a desirable method where drainage is anticipated.

ANTEROLATERAL ABDOMINAL SECTION

BY THE HARRINGTON-WEIR PROLONGATION OF THE ANTEROLATERAL INTRAMUSCULAR INCISION THROUGH THE RECTAL SHEATH, WITH TEMPORARY DISPLACEMENT OF THE RECTUS

Description.—Having entered the abdominal cavity by the intramuscular operation just described, an extension or enlargement of that incision, with a fuller exposure of the abdominal, pelvic, and iliac cavities, may be obtained by continuing the incision to the outer border of the rectal sheath, tearing off the "denuded fascia of the external oblique muscle," incising transversely the remaining structures forming the anterior layer of the rectal sheath, and displacing the rectus muscle toward the median line, followed by the transverse division of the posterior rectal sheath. While the operation is chiefly applicable to the region of the appendix, it may be used on either side of the abdominopelvic region, and also in the region of the liver and gall-bladder where additional room is necessary. It will be here described in connection with appendicectomy.

Preparation _ Position.—As in McBurney's Intramuscular Operation (page 121).

Landmarks.—McBurney's point (see McBurney's Operation, Landmarks, page 122); linea alba; semilunar line.

Incision.—Begins as an ordinary McBurney intramuscular incision _ and, after prolonging the incision to the outer border of the rectus, and after partially tearing off, and retracting inward, the fascia of the external oblique, from the sheath of the rectus, the incision is continued across the anterior layer of the sheath of the rectus in a prolongation of the same line with the intramuscular opening into the peritoneum (or may be continued transversely across) _ followed by the inward retraction of the rectus muscle and transverse division of the posterior rectal sheath. (See Fig. 3321, F.)

Operation.—Proceed exactly as in the McBurney operation, up to the point of entering the abdominal cavity – whether operating upon the right or left side. Continue the separation of the fibers of the external oblique muscle and aponeurosis, in the line of their cleavage, right up to the linea semilunaris (outer border of the rectal sheath). Also continue the separation of the fibers of the internal oblique and transversalis until the inner aspect of the common opening is brought up to the outer margin of the rectal sheath. (See Fig. 3360.)

The already denuded fascia of the external oblique is now separated by blunt dissection from the anterior layer of the sheath of the rectus, from the linea semilunaris inward to the median line – retracting or dividing the overlying structures where necessary. While the denuded and displaced fascia of the external oblique is held retracted, the remaining structures forming the anterior layer of the rectal sheath (aponeuroses of internal oblique and transversalis) are divided transversely, or slightly obliquely, inward, in a line continuing the external oblique intramuscular incision – or, if the abdominal cavity have been already opened and more room be needed, in a line with the intramuscular opening into the peritoneum. Separate the outer border of the rectus from its sheath and retract the muscle inward as far as necessary, lifting it away from the posterior layer of the sheath. Doubly ligate and divide the deep epigastric artery and veins lying upon the transversalis fascia – unless they may be temporarily displaced by retraction. Incise transversely the posterior layer of the sheath of the rectus (which, in the lower part of the abdomen, consists of transversalis fascia alone) and peritoneum, both in the same line as the incision through the anterior layer – thus opening up the abdominopelvic cavity toward the median line.

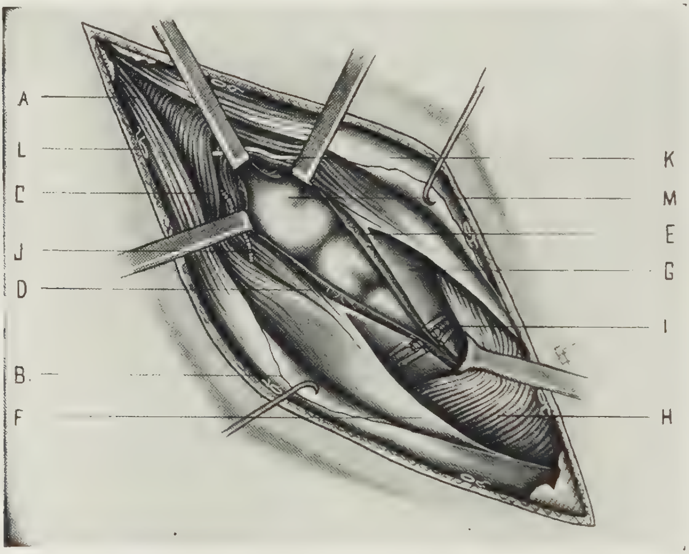


Fig. 3360.—Anterolateral Abdominal Section by the Harrington-Wier Method: – A, External oblique muscle; B, external oblique being separated from the anterior layer of the rectal sheath; C, internal oblique muscle; D, transversalis muscle; E, transversalis fascia, subperitoneal areolar tissue, and peritoneum; F, anterior layer of rectal sheath; G, posterior layer of rectal sheath; H, rectus muscle; I, deep epigastric vessels; J, branch of deep circumflex iliac, or of one of lumbar arteries; K, twelfth intercostal, or iliohypogastric nerve; L, a superficial vessel; M, coils of small intestine.

The abdominal, pelvic, and iliac cavities are thus exposed and the object of the operation accomplished. The suturing of the general wound is done as in the McBurney operation (page 125). In closing the portion involving the rectal sheath, the posterior layer of the sheath is sutured with continued catgut _ the rectus muscle is then allowed to fall back into place _ and the anterior layer of the sheath is similarly closed.

Comment.—Additional exposure is secured by the Trendelenburg position, or by sand-bags under the hips. This is the best one of the modifications of the intramuscular operation for giving increased room.

ANTERIOR ABDOMINAL SECTION THROUGH A VERTICAL INCISION IN THE OUTER PART OF THE RECTAL SHEATH, WITH TEMPORARY INWARD DISPLACEMENT OF THE RECTUS

BY THE BATTLE-KAMMERER-JALAGUIER-LENNANDER METHOD

Description.—Consists, after a vertical incision of skin and fascia, in the vertical division of the anterior layer of the outer part of the sheath of the rectus, with the retraction of the entire rectus inward _ followed by the vertical division of the posterior layer of the rectal sheath, somewhat nearer the median line, together with the subserous areolar tissue and peritoneum. At the end of the operation the rectus is allowed to resume its normal position, and the divided rectal sheath is repaired. Chiefly used in appendicitis _ and also applicable in some operations upon the abdominal viscera. The abdominal nerves are sought, and preserved.

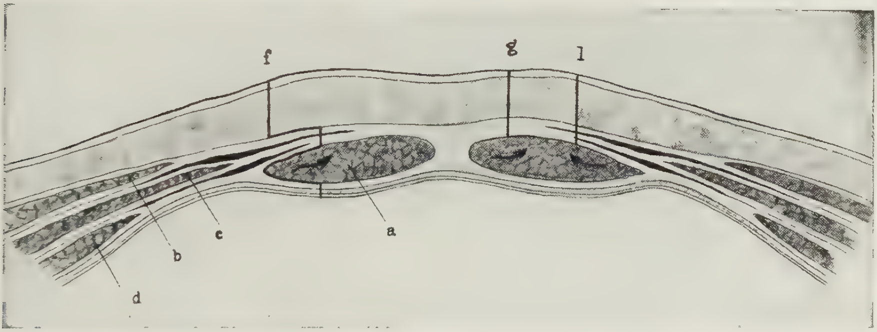


Fig. 3361.—Lines of Abdominal Section Through the Rectal Sheath, in Connection with the Temporary Displacement of the Rectus Muscle, in Operations for Entering the Abdominal Cavity: _ **a**, Rectus; _ **b**, external oblique; _ **c**, internal oblique; _ **d**, transversalis; **e**, line of section usually followed in the Battle-Kammerer-Jalaguier-Lennander abdominal section, followed by inward displacement of the rectus muscle; _ **f**, another line of section sometimes carried out, in Battle's method, with the same displacement of the rectus; _ **g**, another line of section in abdominal exposure, followed by outward retraction of the rectus muscle.

Preparation _ Position.—As in Median Abdominal Section.

Landmarks.—Linea alba and linea semilunaris, forming, respectively, the inner and outer boundaries of the rectal sheath.

Incision.—Vertical incision about 7.5 cm. (3 inches) long, and calculated, as nearly as possible, to fall from 1 to 2.5 cm. ($\frac{3}{8}$–1 inch) internal to the outer border of the rectus. (See Fig. 3321, G.) The level of the incision will depend upon the object of the operation.

Operation.—Incise skin and fascia in the above line _ clamp vessels _ retract overlying tissues _ and expose the rectal sheath. Incise the anterior layer of the sheath of the rectus vertically at a distance of from 1 to 2.5

cm. ($\frac{3}{8}$–1 inch) internal to its outer border. Retract outward the outer portion of the divided rectal sheath, so as to expose the outer border of the rectus muscle – and then retract the intact rectus muscle inward, preserving all nerves encountered (Fig. 3362).

Incise the posterior layer of the rectal sheath somewhat nearer the median line than in the case of the anterior layer. Or, in operating in the neighborhood of the deep epigastric artery, in order to avoid this vessel, the incision in the posterior layer may be made somewhat further outward than the incision through the anterior layer. The artery may, however, be readily ligated if in the way. In the same line as the division of the posterior layer of the rectal sheath incise vertically the subjacent tissues – which will consist of transversalis fascia, subperitoneal areolar tissue, and peritoneum, except below the semilunar fold of Douglas, below which line the posterior layer of the sheath itself consists of transversalis fascia alone, and the subjacent tissues consist of subperitoneal areolar tissue and peritoneum.

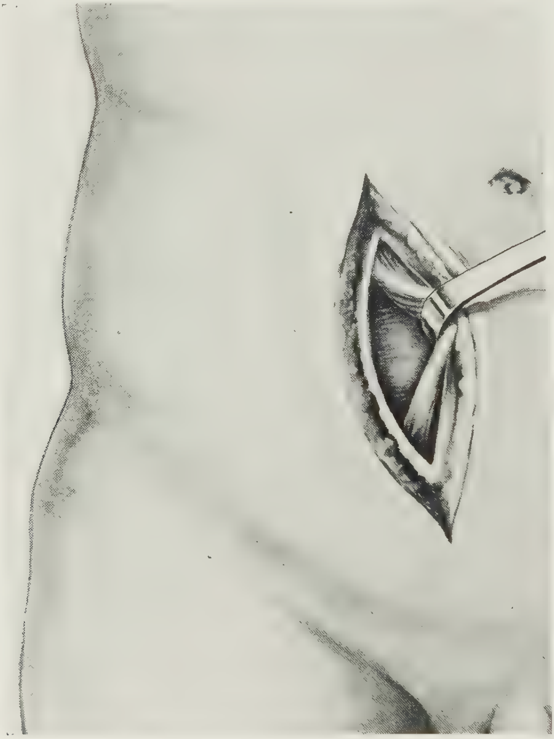


Fig. 3362.—The Battle, Kammerer, Jalaguier, or Lennander Operation for the Exposure of the Abdominal Cavity; – The anterior layer of the rectal sheath has been opened by an incision overlying its outer aspect – and parallel with, and within, the outer margin of the sheath. The surface of the rectus is thus exposed – after which its outer border is freed from its sheath by blunt dissection – and the entire muscle displaced toward the median line.

Having accomplished the object of the operation, the structures are to be sutured in the following layers: – peritoneum, subserous areolar tissue, and posterior layer of the rectal sheath, with interrupted or continuous catgut suture; – anterior layer of rectal sheath with interrupted gut sutures, which may also pass partly through the rectus muscle (the displaced border of the rectus may also be sutured to the outer margin of the rectal sheath); _ the fascia, with gut _ and the skin with subcuticular silk, or interrupted silkworm-gut sutures (or skin and fascia may be sutured together).

Comment.—One should endeavor to retract and avoid the divisions of the nerves corresponding with the incision, and consequent atrophy and paresis of the rectus. The nerves severed in the site where the operation is usually performed (for appendicitis) being generally the tenth, eleventh, and twelfth dorsal, with or without the iliohypogastric. The deep epigastric artery can generally be displaced _ but may be divided if in the way.

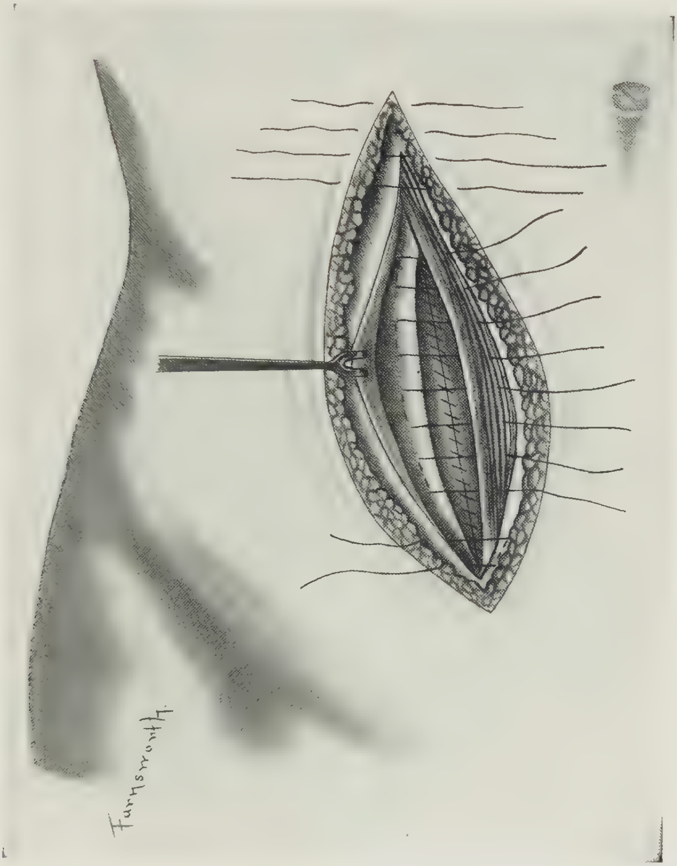


Fig. 3363.—"Overlapping" Closure of Exposure of Abdominal Cavity Through the Rectal Sheath; _ Line of continuous sutures through peritoneum, subserous areolar tissue, and transversalis fascia; interrupted mattress-sutures passing through posterior layer of outer portion of rectal sheath on the left, and posterior layer of rectal sheath and outer aspect of rectus on the right; mattress-suture passing through inner aspect of anterior layer of rectal sheath on the right, and the outer aspect of the anterior layer on the left; interrupted skin sutures. (The upper end of the rectus should be like the lower, and not appear to dove-tail.)

Several modifications of technic are employed _ generally either to secure more room _ or to interpose greater barriers to hernia. In the majority of instances no sutures are carried through the rectus _ the posterior and anterior openings into the rectal sheath being sutured in the ordinary manner, and the muscle being allowed merely to fall back into its normal position, which it tends to do.

The incision of approach may not lie directly over the line along which the outer layer of the rectal sheath is going to be incised – but may lie over the semilunar line – then, when the extreme outer limit of the rectal sheath is encountered, one retracts the inner lip of the skin and fascial wound, mediad – until the outer third of the rectal sheath is reached, when the vertical incision through it is made – after which the outer border of the rectus is displaced inward, and the posterior layer of the sheath is incised.

The closure is usually made by simple suturing, but may be made by the overlap method (Fig. 3363).

ANTERIOR ABDOMINAL SECTION THROUGH A VERTICAL PARAMEDIAN INCISION IN THE INNER PART OF THE RECTAL SHEATH, WITH TEMPORARY OUTWARD DISPLACEMENT OF THE RECTUS

The general principles involved in this operation are the same (except reversed) as in the Battle operation, just considered – except that the incision is over the inner aspect of the rectal sheath, and the rectus muscle is displaced outwardly – rather than over the outer aspect of the sheath, with inward displacement of the muscle, as in the Battle technic.

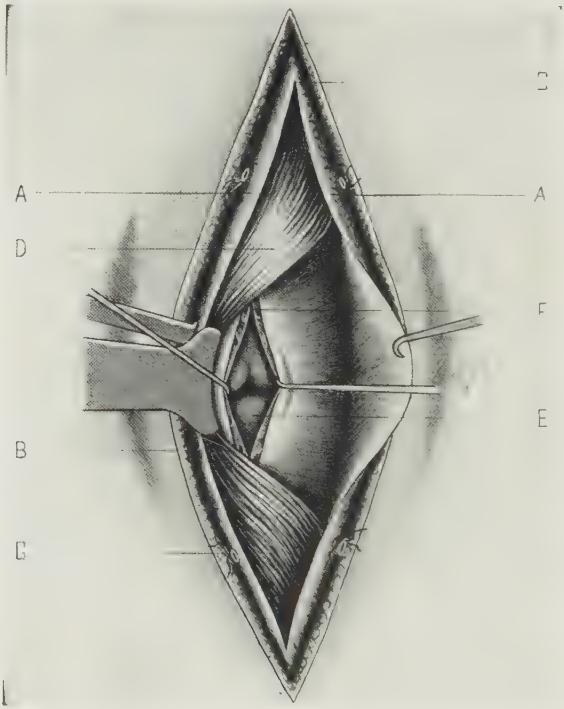


Fig. 3364.—Anterior Abdominal Section Through a Vertical Paramedian Incision in the Inner Part of the Rectal Sheath, with Temporary Outward Displacement of the Rectus: – A, A, Anterior layer of rectal sheath; B, posterior layer of rectal sheath; C, incision through anterior layer of rectal sheath; D, right rectus muscle displaced outward; E, incision through posterior layer of rectal sheath (further toward median line than incision through outer rectal sheath) exposing coils of intestine; F, transverse fascia, subperitoneal areolar tissue, and peritoneum; G, a superficial vessel. The operation is here shown on the right side.

A paramedian incision is made parallel with the median line, and from 5 mm. to 3 cm. ($\frac{3}{8}$–$1\frac{3}{8}$ inches), either to the right or left of the linea alba _ with its center nearest to the object sought.

The skin, fascia, and anterior layer of the rectal sheath are incised along this line. The anterior cut portion of the sheath is retracted outward until the inner border of the rectus is exposed, when the muscle is bodily retracted outward (Fig. 3364) _ after which the posterior layer of the rectal sheath is incised in the same line as the anterior layer.

Upon completion of the operation the posterior sheath is sutured _ the rectus allowed to fall back into place, after which it is usually sutured to the median line, with two or three catgut stitches _ the anterior sheath sutured _ and the wound closed.

The chief feature of advantage of this over the preceding operation is that the nerve supply of the rectus is not endangered _ in that its inner, rather than outer, aspect is exposed _ and that the retraction is outward (toward the nerve supply) rather than inward (away from it).

A disadvantage of the present operation (not shared by the preceding) is that if it be found necessary to get more room toward the flank, the retracted rectus stands in the way _ while, on the other hand, that fact affords access toward the median and opposite side (which, in turn, the Battle procedure does not). In a way the Battle and this operation may be considered reciprocal of each other.

MEDIAN INFERIOR ABDOMINAL SECTION

BY PFANNENSTIEL'S SUPERFICIAL TRANSVERSELY CURVED AND DEEP VERTICAL INCISIONS

Description.—A method of entering the peritoneal cavity in the lower median abdominal region _ by means of a superficial curved incision, with downward convexity, just above the inner halves of Poupart's ligaments and the symphysis, with an upward retraction of the outlined flap of skin, fascia, and anterior rectal sheath _ followed by a deep vertical division in the median line. A median scar is avoided, and the transverse scar lies partly hidden by the hair-line. Hernia is supposed to be less apt to follow. Chiefly used for limited operations upon the tubes, ovaries, uterus, bladder, and pelvic cavity.

Preparation _ Position.—As for Median Abdominal Section.

Landmarks.—Linea alba; position of deep epigastric arteries; Poupart's ligaments; symphysis pubis.

Incision.—(**1**) Superficial transversely curved incision, with downward convexity, beginning and ending over the deep epigastric arteries, passing just above the inner halves of Poupart's ligaments and the symphysis pubis, in the hair-line; _ (**2**) Deep vertical incision, after the anterior layer of the rectal sheath has been retracted, passes between the inner borders of the recti muscles, in the median line, from just above the symphysis pubis upward. (See Fig. 3321, I and H.)

Operation.—Incise skin, fascia, and anterior layer of rectal sheath in the superficial transversely curved incision. Clamp vessels. Dissect and retract the curved flap thus formed upward, including the anterior rectal sheath thereby exposing the bared recti muscles. (See Fig. 3365.)

Incise between the inner borders of the recti and pyramidales muscles, just as in median abdominal section, until the peritoneal cavity is reached, which is entered just as in that operation. Having accomplished the object of the operation, the wound is sutured in the following manner: _ The posterior layer of the rectal sheath is closed with continued catgut suture, including the edges of the peritoneum and subserous areolar tissue _ the inner margins of the recti are next sutured with gut _ the cut edge of the transversely divided anterior rectal sheath is similarly sutured with gut _ and the skin wound is closed with silk or silkworm-gut.

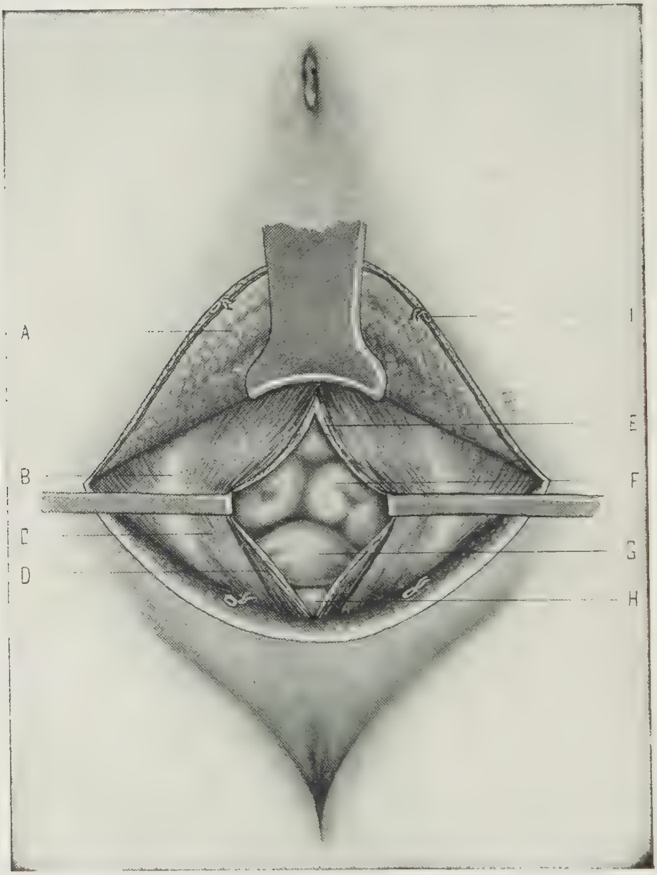


Fig. 3365.—Abdominal Section by Pfannenstiel's Superficial Transversely Curved and Deep Vertical Incisions: _ A, Flap, with anterior layer of rectal sheath adherent, turned upward; B, linea semilunaris; C, rectus muscle; D, pyramidalis muscle; E, transversalis fascia, subperitoneal areolar tissue, and peritoneum; F, coils of small intestine; G, uterus; H, bladder; I, a superficial vessel.

Comment.—Care is necessary to avoid wounding the bladder, which should be empty at the time of operation.

INFERIOR ANTEROLATERAL ABDOMINAL SECTION

BY MEYER'S "HOCKEY-STICK" INCISION

Description.—A method of entering the lower anterolateral abdominal cavity, partly by intramuscular separation, partly by transverse division of muscle, by means of an incision shaped somewhat like a "hockey-stick." Resorted to for the purpose of gaining a greater degree of exposure of the abdominopelvic cavity than afforded by the simple McBurney incision. Used by its originator for some complicated cases of appendicitis.

Preparation _ Position.—As in McBurney's Operation.

Landmarks.—Imaginary line from umbilicus to anterior superior iliac spine, with the location of McBurney's point (see McBurney's Operation, Landmarks, page 122); Poupart's ligament; outer border of the rectus; deep epigastric artery.

Incision.—(1) Primary incision, _ begins about 1.3 cm. ($\frac{1}{2}$ inch) above an imaginary line from the umbilicus to the anterior spine of the ilium, at a point 2 cm. ($\frac{3}{4}$ inch) to the inner side of the anterior superior iliac spine (that is, midway between McBurney's point and the anterior superior iliac spine), and passes thence in a direct line toward the point where the femoral artery runs under Poupart's ligament, ending about 1.3 to 2 cm. ($\frac{1}{2}$–$\frac{3}{4}$ inch) above Poupart's ligament. (2) Secondary incision, which is only made subsequently, for the purpose of gaining more room, passes upward and inward, or curves directly inward, from the lower end of the primary incision toward the outer border of the rectus. (See Fig. 3321, J.)

Operation.—Incise skin and fascia in the line of the primary incision _ clamp vessels _ and retract margins of wound. Split the fibers of the external oblique muscle and its aponeurosis in their cleavage line. Divide the internal oblique and transversalis in the same line as made by the separation of the fibers of the external oblique _ which will cut the fibers of the internal oblique transversely and those of the transversalis obliquely. Incise the transversalis fascia, subserous areolar tissue, and peritoneum transversely.

If more room be now necessary, the left index is passed into the abdominal cavity to the deep epigastric artery, as a guide and protector, and the lower end of the incision is extended upward and inward, or directly inward, to the outer border of the rectus muscle. If still more room be needed, the rectal sheath can be transversely incised, and the rectus muscle itself can be displaced inward and the peritoneum incised beneath it. The object of the operation is now accomplished. The wound is then closed by tier suturing.

Comment.—The deep epigastric vessels are doubly ligated and divided, if necessary. Division of muscle tissue is, of course, undesirable, if avoidable.

INFERIOR ANTEROLATERAL ABDOMINAL SECTION

BY FOWLER'S ANGULAR INCISION

Description.—Founded, in part of its application, upon the same principle as McBurney's intramuscular operation _ and planned to give freer access to the contents of the ileocecal region, and especially to the base of the appendix. Especially intended by its author for cases of appendicitis in which the process is still limited to the appendix.

Preparation _ Position.—As in McBurney's operation.

Landmarks.—Anterior superior iliac spine; outer border of the rectus.

Incision.—Begins at the upper border of the anterior superior iliac spine _ runs horizontally inward to the outer border of the rectus muscle _ curves thence downward and runs parallel with the outer border of the rectus for 5 to 7.5 cm. (2–3$\frac{1}{2}$ inches). (See Fig. 3321, K.)

Operation.—Incise skin and fascia in the above line _ clamp vessels _ and turn downward and outward this triangular flap of skin and fascia, exposing the aponeurosis of the external oblique beneath. Place retractors at the center of the transverse incision and at the lower angle of the wound, and retract in the cleavage line of the external oblique (Fig. 3366). Incise the external oblique muscle and aponeurosis in the cleavage line of their fibers, and retract in the direction opposite to their cleavage line. Expose and open the sheath of the rectus and retract the rectus muscle, with the deep epigastric vessels, strongly toward the linea alba _ while retracting the aponeurosis to the outer side. Incise transversely, in line with the horizontal part of the skin incision, the internal oblique and transversalis muscles, transversalis fascia, subserous areolar tissue and peritoneum, all as one structure _ beginning at the outer margin of the retracted rectus (Fig. 3367). And retract the deep lips of the wound, exposing the abdominal cavity. The special object of the operation is now accomplished.

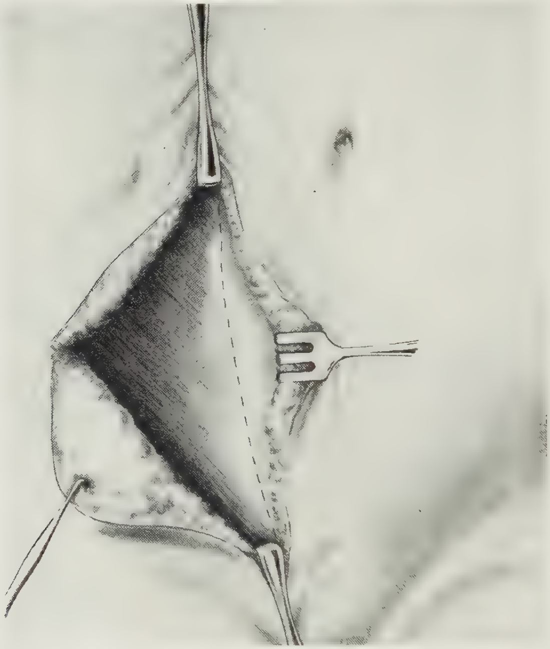


Fig. 3366.—Anterolateral Abdominal Section, Through the Rectal Sheath and the Lateral Abdominal Muscles and Aponeuroses _ Fowler's Method _ I; _ The margins of the incision, shown in Fig. 3321, K have been retracted _ and the outer aspect of the anterior layer of the rectal sheath will be incised along the dotted line.

At the completion of the operation the structures are sutured in the following order: _ Peritoneum, subserous areolar tissue, transversalis fascia, transversalis and internal oblique muscles are all sutured in one layer, with continuous chromic gut; _ the rectus is allowed to fall back into place; _ the external oblique aponeurosis and muscle are sutured with continuous kangaroo-tendon, in which layer the rectal sheath is also included; _ and the skin is closed by a subcuticular silk suture (and the fascia separately with gut, if it be very thick).

Comment.—In applying the above operation to cases of appendicitis Fowler considers the base of the appendix to be most generally found at the intersection of a transverse line between the anterior superior iliac spines with a vertical line running midway between the median line of the body and the anterior superior iliac spine.

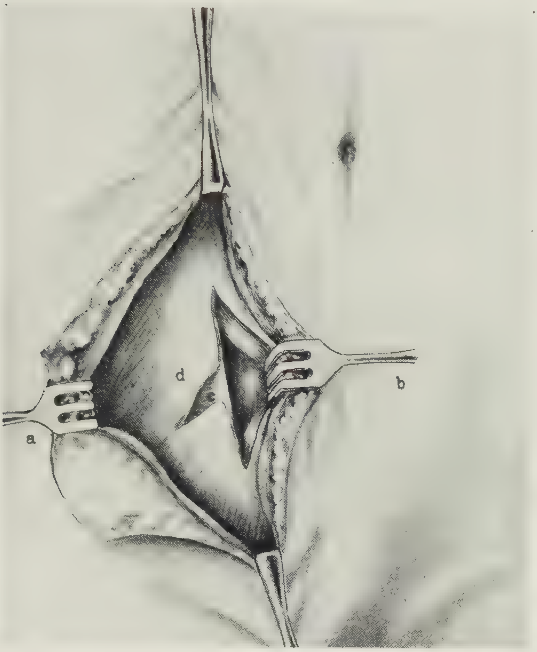


Fig. 3367.—The Same _ II: _ **b,** The anterior layer of the rectal sheath has been displaced inward _ and the outer border of the rectus muscle, freed by blunt dissection, is similarly drawn mediad; _ **d,** the aponeurosis and muscular fibers of the internal oblique have been split in their cleavage line _ to gain more room; _ **c,** the transversalis, in the bed of the wound _ whose fibers may also be incised in their cleavage line.

This operation gives no more room than Weir's _ and neither operation divides muscle-fibers transversely.

SUPERIOR ANTEROLATERAL ABDOMINAL SECTION

BY OBLIQUE SUBCOSTAL INCISION

Description.—A method of entering the abdominal cavity parallel with and a short distance below the costochondral arches. Generally resorted to for the exposure of the subhepatic, gastric, and splenic regions.

Preparation _ Position.—As in Median Abdominal Section.

Landmarks.—Costochondral arches.

Incision.—Generally parallel with and about 2.5 cm. (1 inch) below the costochondral arch of one or the other side _ with the center of the incision over the object sought. (See Fig. 3321, L.)

Operation.—Incise skin and fascia _ clamp vessels _ retract lips of wound. Incise external oblique, which will be aponeurotic above and muscular below _ the incision crossing its fibers about at a right angle. Separate the fibers of the internal oblique in their cleavage line _ which may be done external to the outer border of the rectal sheath. Incise the transversalis parallel with the costochondral border, which will be perpendicular to their fibers. Incise the transversalis fascia, subserous areolar tissue, and peritoneum in the same line with the preceding incision _ and thus enter the peritoneal cavity.

Having completed the object of the operation _ suture the structures in the following layers with buried catgut; _ peritoneum, subserous areolar tissue, transversalis fascia; _ transversalis and internal oblique muscles; _ external oblique; _ and fascia and skin with silk or silkworm filament.

Comment.—This incision corresponds with the cleavage line of the skin _ and especially corresponds with the course of the seventh and eighth intercostal nerves, which run upward and are thereby uninjured. The incision can be prolonged up to the rectus muscle followed by a transverse incision of its anterior sheath, with inward retraction of the intact muscle _ and a similar transverse division of its posterior sheath _ the sheath being sutured at the end of the operation. For the application of this incision see operations upon the stomach.

EXPOSURE OF HYPOCHONDRIAC REGIONS BY CHONDROPLASTIC RESECTION OF CHEST WALL

BY SUBCOSTAL INCISION AND TEMPORARY DIVISION OF SEVENTH, EIGHTH, NINTH, AND TENTH COSTAL CARTILAGES

Owing to the rigidity of the chest wall it is difficult to satisfactorily expose the dome of the diaphragm, the upper surface of the liver, the lower end of the esophagus, and the cardiac end of the stomach and the spleen. By the temporary resection of the costal arch of either the right or left side, as indicated, these structures are much more readily brought into the operative field.

The details of this operation have been given under Thoracic Operations, page 63.

LATERAL ABDOMINAL SECTION

BY VISCHER'S LUMBO-ILIAC INCISION

Description.—Consists in the separation of the muscular and tendinous fibers of the abdominal muscles of the lumbo-iliac region, just above the center of the iliac crest, in their cleavage lines, without transverse division of muscle-fibers, or harm to abdominal nerves _ and exposing the operation-site by retraction of the separated muscles. Applicable to exposure of structures in the above region, and especially for suppurating cases of appendicitis _ being advantageous because of the ability to extend the opening from either end of the original incision.

Preparation.—As in McBurney's operation.

Position.—Patient partly turned toward opposite side, with pad placed beneath involved side, to render site of operation prominent. Surgeon on side of operation. Assistant opposite to surgeon.

Landmarks.—Crest of ilium; anterior superior iliac spine; Poupart's ligament.

Incision.—Runs 2.5 cm. (1 inch) above and parallel with the crest of the ilium, beginning at the outer border of the external oblique (which corresponds with about the center of the iliac crest) and ending opposite the anterior superior iliac spine _ or may extend forward parallel with the outer part of Poupart's ligament. (See Fig. 3321, M.)

Operation.—Incise skin and fascia in the above line _ clamp vessels _ retract lips of wound, exposing the external oblique. The fibers of the external oblique are now separated in their cleavage line. As the fibers of the muscular portion run somewhat more vertically here than the line of the skin incision, a good, free length of separation is necessary, with firm retraction inward and upward, and outward and downward, respectively, in order to expose the internal oblique. The fibers of the internal oblique, which run upward and inward, are similarly separated in their cleavage line, and retracted upward and backward, and downward and forward _ carefully guarding all important nerve structures between the internal oblique and transversalis, which latter muscle is now exposed. The fibers of the transversalis, running transversely inward, practically in the same line with the internal oblique, are now separated in like manner in their cleavage line, and retracted upward and downward, exposing the transversalis fascia. The transversalis fascia, subserous areolar tissue, and peritoneum are divided vertically and the peritoneal cavity entered. Upon completion of the operation the structures are sutured as in McBurney's operation (page 125).

Comment.—More room may be gotten anteriorly by continuing the separation of the aponeurotic fibers of the external oblique parallel with Poupart's ligament, in the line of the original incision, and posteriorly and superiorly, by continuing the separation of the muscular fibers and lumbar aponeurosis. A branch of the deep circumflex iliac artery, between transversalis and internal oblique, is clamped and divided.

CHAPTER LXIII

OPERATIONS FOR HERNIÆ OF THE INTESTINAL TRACT

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Operations for Hernia Through the Linea Alba, or Epigastric Hernia, p. 143

Surgical Anatomy of Umbilical Hernia, p. 144; — General surgical considerations in operating for umbilical hernia, p. 145; — Radical operation for continued prolapse of the navel, in nursing children (Spitzy), p. 145; — Operation for the radical cure of umbilical hernia by median vertical elliptic incision, followed by the median approximation of the recti, and the vertical overlapping of their outer aponeuroses, p. 147; — Operation for the radical cure of umbilical hernia by excision of the sac and transverse overlapping of the abdominal aponeuroses (Mayo), p. 151; — Operation for the radical cure of umbilical hernia by excision of the sac and vertical overlapping of the abdominal aponeuroses (Blake), p. 156; — Radical operation for combined umbilical hernia and marked diastasis of the recti muscles (Lexer), p. 158; — Plastic repair of the abdominal wall for relative hernia (Coffey), p. 160.

Radical Operation for Lateral Ventral Hernia (Mayo), p. 162.

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Femoral Hernia, p. 190; — Surgical anatomy, p. 190; — General surgical considerations, p. 191; — Operations for the radical cure of femoral hernia (Bassini), p. 192; — Operation for the radical cure of femoral hernia (Kocher), p. 193; — Other operations for femoral hernia, p. 194; — Operation for strangulated femoral hernia, p. 197.

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OPERATIONS FOR HERNIÆ, IN GENERAL

Definition.—Hernia, as used in the present chapter, is the protrusion of any abdominopelvic viscus, or tissue, through any part of the abdominopelvic wall.

Classification.—No entirely satisfactory classification of herniæ has been presented, nor even a satisfactory basis for such arrangement. The following summary represents, largely, a modification of Ferguson's excellent topographic grouping of herniæ.

(*a*) **Anterior Herniæ:**

- Epigastric (just beneath the ensiform cartilage) — acquired or congenital
- Urachal (into the remains of the urachus).
- Umbilical (rather para-umbilical than transumbilical).
- Ventral (median or lateral).
- Inguinal:
  - Oblique (through inner ring, inguinal canal, and outer ring) — acquired, congenital, infantile (posterior to funicular peritoneum), or interstitial.
  - Direct (through Hesselbach's triangle).
    - Internal direct — to inner side of obliterated hypogastric artery.
    - External direct — to outer side of obliterated hypogastric artery.
  - Pre-inguinal (interstitial) — to outer side of inguinal canal (with mouth of sac near inner abdominal ring).

Sliding (displacement of non-peritoneally covered intestine, as cecum or sigmoid).
Cruroproperitoneal (Kroenlein).
Para-inguinal properitoneal (Bruggier)
Inguino-interstitial _ (not extending beyond external abdominal ring _ Boyer or Goyraud).
Intra-iliac (protrusion of iliac fascia into internal iliac fossa).
Labial (anterior or posterior).
Scrotal.

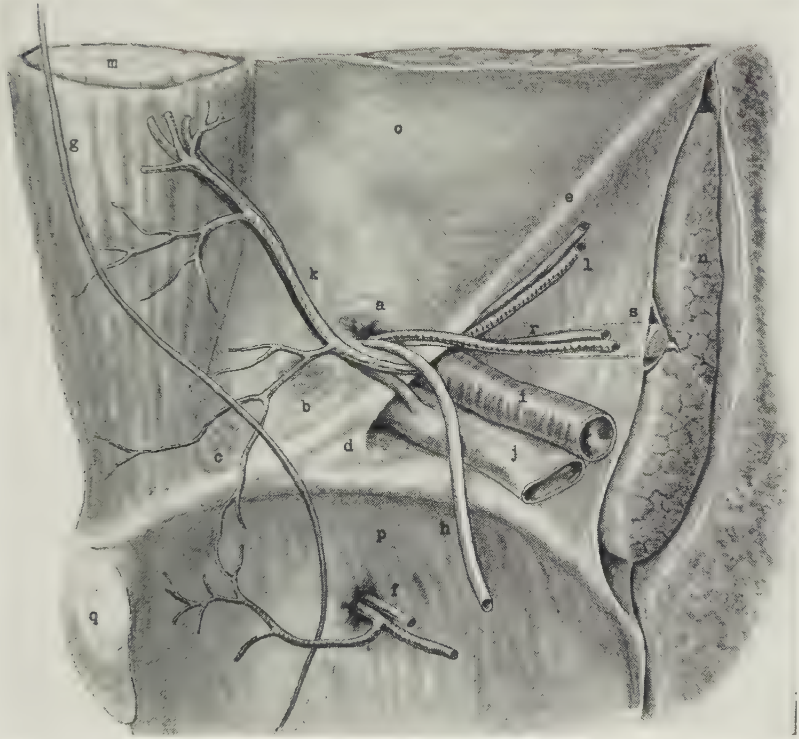


Fig. 3368.—Inner Openings of the Commoner Herniæ of the Pubic and Femoral Regions and Their Relations: _ **a**, Inner ring of oblique inguinal hernia; _ **b**, depression marking the site of a more outwardly placed direct inguinal hernia; _ **c**, depression marking the site of a more inwardly placed direct inguinal hernia; _ **d**, femoral canal, the inner portal of femoral hernia, bounded, internally, by the margin of Gimbernat's ligament, and, externally, by the femoral vein; _ **e**, Poupart's ligament; _ **f**, obturator canal, traversed by obturator hernia; _ **g**, remains of the hypogastric artery; _ **h**, vas deferens; _ **i**, femoral artery; _ **j**, femoral vein; _ **k**, deep epigastric vessels; _ **l**, circumflex iliac vessels; _ **m**, rectus muscle; _ **n**, iliacus muscle; _ **o**, transversalis fascia; _ **p**, pelvic fascia; _ **q**, symphysis pubis; _ **r**, spermatic vessels; _ **s**, anterior crural nerve. (Modified from Gray.)

Femoral (through femoral canal):
  Saphenous (through saphenous opening _ Béclard).
  Pectineal (posterior to pectineous muscle _ Cloquet)
  Through Gimbernat's ligament (Laugier).
  Ascending subcutaneous.
  Anterior to vessels (Velpeau).
  Posterior to vessels.
  Internal to vessels.

Inguinofemoral (associated inguinal and femoral – Holthouse).
Anterior retroperitoneal (inward along psoas muscle toward pelvis, and upward from internal abdominal ring – Treves).

(*b*) **Posterior Herniæ:**
Dudenojejunal – (*a*) Into lower duodenojejunal fossa, – (*b*) Upward into lesser sigmoid cavity.
Ileocecal – extending behind cecum, into ileocecal fossa.
Ileocolic – into ileocolic fossa.
Intersigmoid – at intersigmoid fossa of sigmoid mesocolon.
Retrocecal – protrusion of small intestine behind cecum.
Sacrorectal – protrusion of small intestine in sacrorectal region.

(*c*) **Lateral:**
Lumbar – emerging between last rib and pelvic rim – (congenital, into Petit's triangle – or acquired).
Hernia of liver, spleen, or kidney – (hepatocele, splenocele, or nephrocele).

(*d*) **Superior:**
Diaphragmatic.

(*e*) **Inferior:**
Obturator or infrapubic – through obturator foramen.
Ischiatic or sciatic – through sacrosciatic foramen.
Perineal or ischiorectal – upon the pelvic floor.
Sacrorectal – a posterior type of hernia occurring in malossification of the sacrum.
Vaginal – which may be either rectovaginal, or vesicovaginal.
Vesical – which may be either vesicorectal, vesico-inguinal, or vesicofemoral.
Rectocele – which is sometimes confused with postanal deformities.
Hernia into Douglas' culdesac.

(*f*) **Internal:**
Foraminal – through the foramen of Winslow, into the lesser peritoneal cavity.
Mesenteric – through a congenitally weak area of the mesentery (Cooper's retroperitoneal hernia).
Diverticular – through the mesentery of Meckel's diverticulum.
Omental – through a congenitally weak area of the omentum.

Other bases exist for the subclassification of the many varieties of herniæ – such as the nature of the contents of the hernial sac – the form of the sac – or upon some predominant clinical feature of the sac – going into many refinements which are confusing in their complication, – some of which are self-evident – and others are not of practical operative bearing.

Many features concerning the anatomy and pathology of the various types of hernia will be found in works upon General Surgery – and others will be briefly stated under the special form of hernia to which they apply.

Indications for Operation.—The indication for operation in hernia may be reduced practically to two, – either for the relief of constriction, in strangulated hernia, when immediate operation is imperative, – or, for the radical cure of the hernia, by the closure, or narrowing of the opening through which the protrusion occurs. Operation for non-strangulated hernia is always undertaken for its radical cure. Formerly, operation for strangulation was simply to save life – and only resulted in cure by accident, as it were. At the present time, following the relief of the constricted intestine, or part, by operation, the wound is closed by some step which undertakes the radical cure of the hernia by preventing subsequent protrusion.

Contraindications.—The extremes of life (rarely under two or three years, or over sixty or sixty-five); – the presence of acute disease, or of local skin disease; – serious organic or chronic disease; – some exceedingly large herniæ. The presence of strangulation takes precedence over even these.

As has been mentioned, operation is either for the relief of strangulation or for radical cure.

General Nature of Operations for Herniæ.—The characteristic feature for the relief of an acutely constricted hernia, is the division of the tissues which compress the neck of the sac in its passage through some part of the abdominal wall, and which constitute the constricting band. The essential feature of all operations for the radical cure of hernia is to bring about such plastic repair of the opening through which the hernia has protruded as to make any further protrusion impossible or unlikely. Unfortunately, while lessening of the opening is generally possible, obliteration of the opening through which the hernia has protruded is usually impossible. Where a hernia (such as a ventral hernia) breaks through some region which is not the site of a natural opening for the exit of some structure, the complete closure of the site of rupture is generally possible. But where the hernia (such as an inguinal or femoral hernia) protrudes through a region which is the site of exit of some important structure, the hernial opening cannot be obliterated – as the opening must still serve as the exit of the spermatic cord, or the femoral vessels, from the abdomen, in inguinal or femoral hernia, respectively – and, in such cases, all that can be done is to so decrease these openings, and reinforce them, by various measures of plastic procedure, as to make subsequent escape of abdominal contents through the site very difficult and unlikely, if it cannot be made impossible.

In order to correctly comprehend the essential features common to all herniæ which occur through natural openings in the abdominal wall, it is necessary to remember that the structures which emerge from the intra-abdominal (not intraperitoneal cavity, lie upon some aspect of the abdominal wall proper which is covered by the intra-abdominal fascia (variously called diaphragmatic, transversalis, pelvic, etc. – spoken of, at large, as the transversalis fascia, and everywhere continuous, independently of differences in nomenclature) – between which and the peritoneum, intervenes the properitoneal, or subserous areolar tissue, more or less developed, in different localities and persons. The structures which make their normal exit through the normal abdominal openings, rest upon the intra-abdominal, or transversalis fascia – and are covered (from without, inward) by subserous or properitoneal areolar tissue, and then by peritoneum. The intra-abdominal or transversalis fascia presents unusual strength and resistance, especially in those regions where herniæ are most apt to occur, and its integrity is of especially great importance in the prevention of hernia – and seems, alone, capable of preventing hernia. It is the attempt to close this opening in the transversalis fascia that would constitute the chief object of hernial operation, if it were possible – but since this cannot be accomplished (in the instances mentioned), its blockage and the reinforcement of the neighborhood by adjacent aponeurotic structures, by overlapping, or otherwise, are the measures resorted to for the radical cure of hernia.

Structural Features Common to All Herniæ.—These consist in the presence of two contributions from the cavity from which the hernia comes – the sac, and its contents, – and a single contribution from the wall through which it protrudes the constricting opening, which binds the neck of the sac. The sac will consist of the various structures which have formed barriers to the exit of the hernia, and will differ according to the locality of the rupture – the

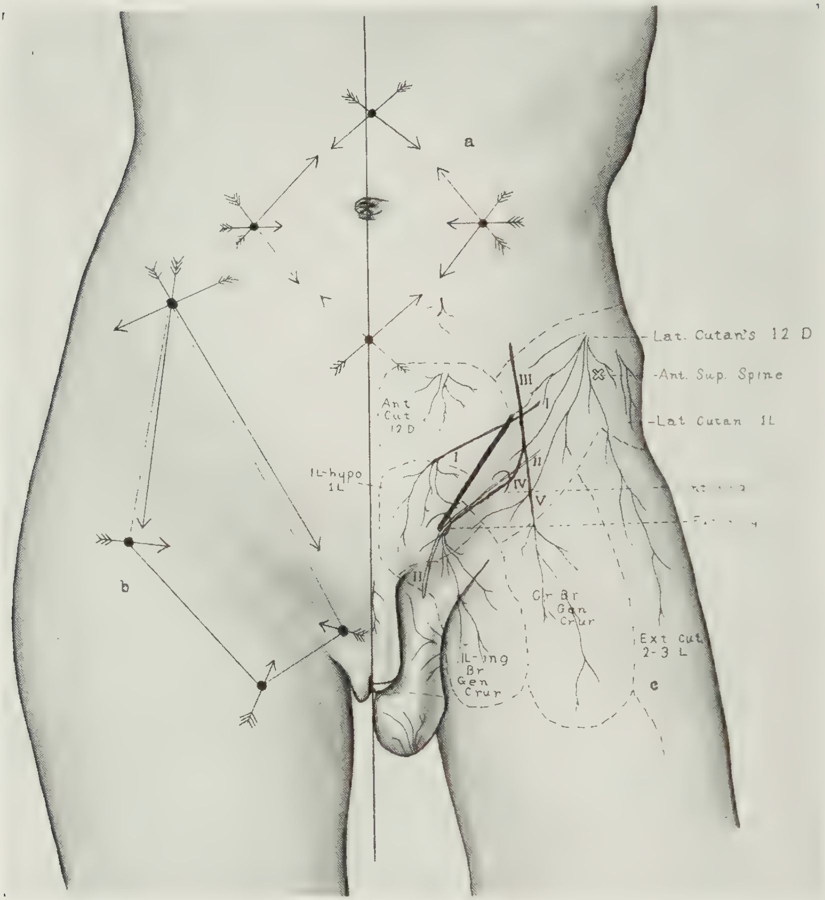


Fig. 3369.—Sites of Injection in Infiltration Analgesia in Operating for Herniæ _ I; _ Braun's Method, in umbilical hernia _ In large herniæ as much as 250 c.c. of a 0.5 per cent. novocain-suprarenin solution may be used. The solution is injected through the abdominal wall nearly to the peritoneum _ which is rather readily accomplished when the hernia can be reduced, and a finger within the ring guides the needle _ otherwise, the injection must be made by judgment, as to penetration.

II; _ Braun's Method in femoral hernia _ Four sites are selected for injection _ a point three fingerbreadths from the anterior superior iliac spine, toward the median line _ points on each side of the hernia _ and a point below the hernia.

III; _ Cushing's field of nerve distribution and points for infiltration-analgesia injection are shown on the patient's left _ as indicated.

IV; _ Braun's Method in oblique inguinal hernia is not separately shown _ but, using Cushing's mapped-out field, Braun selects two points; _ A point three fingerbreadths internal to the anterior superior iliac spine, on a line with the pubis _ and a point just over the horizontal ramus of the pubis, at the outer inguinal ring. From these points injections are made in the direction of radiating lines, through the cutaneo-aponeuro-muscular thickness of the abdominal wall, but avoiding the invasion of the peritoneal cavity. The genitocrural, external spermatic, lumbo-inguinal, iliohypogastric, and anterior cutaneous branches of the twelfth intercostal are thus blocked.

The female figure is represented upon the patient's right _ and the male, upon the left. The illustration is otherwise modified from Cushing and from Braun.

innermost layer of the sac always being the peritoneum protruded ahead of the herniating structure. The contents of the sac will differ, according to circumstances _ but usually contains intestine, and, generally, only intestine.

The abdominal wall tissues which constrict the neck of the sac will also differ in some details, dependent upon the site at which the rupture takes place.

Operative Features Common to All Herniæ.—These, briefly, consist in: – the opening of the sac, and the restoration of its contents to the abdominal cavity – the excision of the sac – the closure of the peritoneal opening (generally by ligation preceding excision) – the plastic repair of the hernial canal, with an attempt at its obliteration. The details of accomplishing these various ends constitute the distinguishing features of the various technical procedures for the cure of herniæ – and will be found under the different operations described.

Preparation for Operation.—As ample time usually exists, deliberate preparation of the patient, generally, and of the field of operation should be made – especially as the latter, owing to the nature of the part (if in the neighborhood of the pubis), is not readily accomplished – and as primary union of the wound is of paramount importance. It is a noticeable fact in the case of two operations very frequently performed – for hernia and for appendicitis – that there is often a tendency to operate after a preparation so trivial as to be open to justifiable criticism.

Suture and Ligature Material.—There is much difference of opinion and usage as to the material used in suturing. One would suggest the following: – plain catgut No. 1, for ligaturing vessels, and for continuous suturing of incised peritoneum; – chromic gut No. 2 for ligating the hernial sac; – medium kangaroo-tendon for the edge-to-edge, or for overlapping the aponeuroses and tendinous structures (or No. 2 chromic catgut); – No. 1 chromic catgut for fascial planes, if these be thick enough to require separate buried sutures; – and silkworm filament for skin suturing.

Some Surgeons prefer silk or Pagenstecher celluloid thread for uniting the aponeuroses. Silver wire was once quite extensively used in hernia operations.

Anesthesia – Analgesia.—Here, too, there is much variation of opinion. Although very generally employed, analgesia would seem indicated only in those cases where anesthesia is, for some reason, contraindicated. A very good index as to the subjective side of this question is the number of medical men who have been operated upon for hernia under analgesia – who would not consent to a second operation under the same circumstances. Illustrations for the points of puncture, in the usage of analgesia, are given under umbilical, inguinal, and femoral herniæ (Fig. 3369) – for those who desire to use that method.

A very large variety of herniæ have been operated upon by very many different methods. Only the chief varieties of herniæ will be here considered – and only the operative technics which are most generally in use.

OPERATION FOR HERNIA THROUGH THE LINEA ALBA OR EPIGASTRIC HERNIA

Description.—Hernia may occur anywhere in the median abdominal line (and what is here said is exclusive of umbilical hernia) – but is more apt to occur between the ensiform cartilage and the navel (because of the greater width of the linea alba above the umbilicus), and, for this reason, they are frequently termed "epigastric herniæ." They are usually small in size, and generally consist of properitoneal fat only – but it is to be always remembered that properitoneal fat, on dissection, may itself cover a small peritoneal sac, and that the sac may contain a knuckle of intestine or of stomach (or a portion of mesentery). The protrusion occurs between the interdigitating fibers of the aponeuroses of the two sides, which, normally, constitute the linea alba.

Moschowitz states that the initial hiatus in the linea alba is some small vessel which penetrates it _ and that the first tissue which can be forced through it is the fat of the falciform ligament, lying between two layers of peritoneum, and coursing in the median line, or a little to the right of it. Hernia through the linea alba is, strictly, median ventral hernia.

Operation.—The surgical procedure is usually a simple one, though sometimes a confusing one _ owing often to the uncertainty and irrecognizability of the structures. A vertical incision is made directly over the tumor _ which is usually small. Although frequently made up of only properitoneal fat, one should proceed with the knowledge that it may contain a peritoneal sac, with contents _ and that such care should be exercised as when the peritoneum is entered. When the mass of fat is exposed, projecting through the opening in the aponeurosis of the linea alba, or protruding this aponeurosis ahead of it, this mass should be carefully incised and then teased apart, so as to demonstrate whether or not it contains peritoneum. If a peritoneal sac be absent, the protrusion of fat is transfixed at its base _ ligated first on one side, and then on the other _ and cut _ after whicht he pedicle is returned into the properitoneal space. If it contain a peritoneal sac, this is carefully opened, and its interior examined _ omentum being more frequently found than intestine. If omentum be present, the protruding part is ligated and excised. If intestine be present, and is intact, it is returned to the peritoneal cavity. In either event the margins of the fibrous ring which form the boundary of the opening are entirely cleared of the fat which protrudes (and which is drawn out reasonaby far before being ligated) _ after which the opening itself is closed with fine kangaroo-tendon. This may be done by simply suturing the fibrous edges together _ or (and especially so if the opening be a little large) by the overlap method _ in exactly the same manner as described and illustrated in the treatment of umbilical hernia (except as to the direction of the incision). Subcutaneous areolar tissue, if thick, may be united by a few buried sutures _ and the skin, with silkworm filament.

Comment.—If the Surgeon first encounters a mass of fat whose smooth covering he takes for peritoneum, on incising this, he will erroneously consider the properitoneal fat as omentum. After making the approach by the median incision, the aponeurosis may be incised transversely, exactly as is usually done in operating for umbilical hernia _ which is, in fact, a better procedure _ in that there will subsequently be less tendency for the margins of the aponeurotic wound to be separated by distention.

SURGICAL ANATOMY OF UMBILICAL HERNIA

Parts Passing Through the Umbilicus Early in Fetal Life.—Urachus; umbilical arteries; umbilical vein; some of the fetal membranes and part of the digestive tract.

Congenital Umbilical Hernia—A form of hernia existing at birth _ owing to an error of development _ the above conditions persisting.

Infantile Umbilical Hernia.—A form of hernia occurring in the early years of life (generally prior to ten years of age). It is that form of hernia where, after birth, the intestines protrude through or alongside the umbilicus, which, in the latter part of fetal life, transmits only the umbilical vessels.

Method of Normal Closure of the Umbilicus.—(*a*) Several changes in the component structures take place: _ (**1**) Contraction and shrinkage of the umbilical ring after birth _ dividing, by its closure, the umbilical vessels running through the ring. (**2**) Clotting of the vessel contents _ proliferation of connective tissue _ and contraction of the muscle-fibers of the vessels. (*b*) As a result, a firm, fibrous scar is thus formed at the site of the umbilicus, with two sets of fibers decussating about it: _ (1) One set of fibers decussating in the median line: _ (2) Two sets of circular fibers interlacing upon the lateral aspects of the umbilicus.

Site of Umbilical Hernia.—Thus it is seen that the umbilical vessels and ring unite to form scar-tissue _ which, remaining weak for a time _ or subsequently submitted to strain _ may yield to hernia. Hernia occurring after birth, therefore, may make its appearance by two routes: _ (1) Almost invariably hernia comes through the abdominal wall near to, but not through, the umbilicus. (2) Occasionally hernia may come through the umbilical ring _ usually through its upper third (where is the weaker scar-tissue about the umbilical vein) _ and but seldom through the lower two-thirds (where is the stronger scar-tissue of the umbilical arteries and urachus).

Coverings of Umbilical Hernia.—(From within outward)—peritoneum; subserous areolar tissue; transversalis fascia; stretched and distended umbilical scar-tissue; superficial fascia deprived of fat; integument.

GENERAL SURGICAL CONSIDERATIONS IN OPERATIONS FOR UMBILICAL HERNIA

Umbilical hernia is, practically always, a hernia immediately alongside of the umbilicus rather than through it (as explained under Surgical Anatomy p. 144) _ para-umbilical hernia might be a more accurate expression, as applied to the vast majority of cases.

Small umbilical hernia in the very young generally get well under appropriate, consistent truss support.

In adults, umbilical hernia sometimes assumes enormous size _ and the umbilical sac may contain a large part of the intestinal tract. Cullen reports a successful operation in an unusually large umbilical hernia in a woman weighing 464 pounds _ in which he also removed a large part of the cutaneo-areolar abdominal wall. In some such extreme cases the Surgeon will have to determine the advisability of operating in each individual case.

Owing to the thinness of the sac in umbilical hernia one must proceed with extreme care _ the outward aspect of the sac sometimes consisting of practically nothing but peritoneum and skin.

Omentum is usually the first structure which forces itself into the sac _ then, large intestine _ and, last, small intestine. Sometimes part of the stomach enters the sac And with the increase of the hernia, the diastasis between the inner margins of the recti becomes greater and greater.

A number of operative technics have been devised _ but the overlap operation is, undoubtedly, the best. The overlap is usually made transversely (Mayo) _ but is sometimes made from side to side (Blake).

Various forms of plastic procedure upon the parts bounding the hernial opening have been worked out _ and those in which these parts have been delaminated, as it were, separately, and interlapped, or overlapped, constitute the next best type of operation.

Simple union of freshened edges of the hernial opening is not to be depended upon, as a rule _ and would seem warrantable, if at all, only in small, simple herniæ.

RADICAL OPERATION FOR CONTINUED PROLAPSE OF THE NAVEL IN NURSING CHILDREN

SPITZY'S OPERATION

Description.—The condition of continuous patulousness of the navel, with protrusion of the intestinal tract, so often noticeable in the newborn, is one of prolapse of the intestinal canal through the unclosed and weakened opening — rather than of hernia in the usual sense. While these conditions are usually curable by consistently and persistently applied pad pressure, some cases prove obstinate — especially in very restless, straining, crying children, with relatively large openings — and upon these operation must sometimes be performed. Spitzy's technic is a simple one — and the subsequent scar (which is of consequence in girls) is insignificant because of its position, small size, and the fact that it becomes largely drawn up into and lost in the normal folds and irregularities of the navel.

Operation.—A small semicircular incision is made, just outside of the navel (at a distance of about $\frac{1}{2}$ cm., or $\frac{3}{16}$ inch), with its convexity either downward or upward. This is deepened obliquely toward the navel, until the neck of the prolapse is reached — which is then carefully isolated and followed down to the umbilical ring — the protruded sac, however, still remaining connected with the overlying skin. When one-half of the neck of the sac has been freed the semicircular flap with attached sac can be displaced upward,

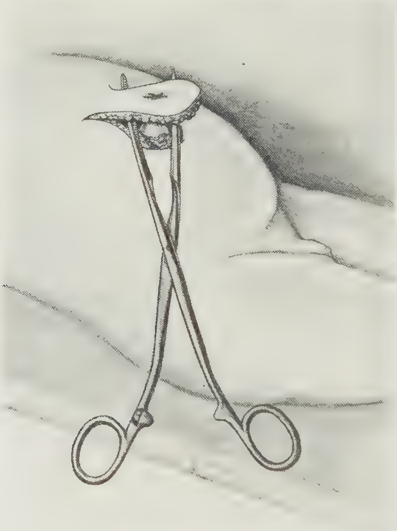
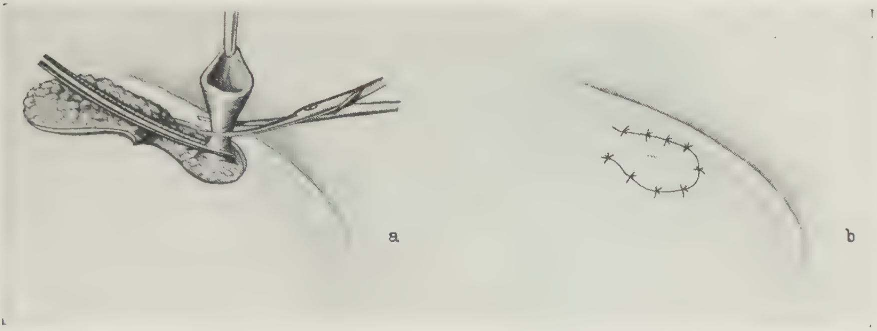


Fig. 3370.—Spitzy's Operation for Hernial Prolapse of the Navel in Young Children — I; — Exposure and isolation of the hernial sac through a semicircular incision.

and from side to side, while the remaining half is freed. The control of the sac during the process of freeing is very much aided by the use of a pair of slender-bladed clamps, whose blades are kept open during the manipulation of mobilization — as shown in Fig. 3370. The sac is then carefully incised near the skin level, after carefully manipulating any contained coil of intestine away from the site. The opening into the sac is carefully enlarged — a small finger introduced — and any abdominal contents found within the sac are returned to the general abdominal cavity. When one is assured that this has been accomplished (and that all the contents of the sac are safely within the abdomen), the clamp, whose opened blades is already in position, is then lowered somewhat — while the sac is also drawn outward somewhat — and the blades closed about the neck of the sac — but not tightly enough to devitalize the parts — after which the redundant portion of the sac, beyond the clamped blades, is excised with scissors (Fig. 3371). While holding (with toothed forceps) the neck of the sac beneath the clamped forceps (to prevent its retreat into the abdominal cavity) the clamp is released. The margins of the peritoneum are then sutured with fine catgut — after which the borders of the umbilical ring are brought together with chromic gut (or, better, fine kangaroo-tendon) — which brings about an approximation of the inner borders of the recti. Spitzy states that the umbilical ring may be closed either by vertical or transverse suturing. It would also seem, in marked cases, where such a course may be indicated, that some form of the overlap operation (such as Mayo's, p. 151, or Blake's, p. 156) might be applied — especially where much diastasis of the recti existed.



Figs. 3371 and 3372.—The Same — II and III: — a, The sac has been opened — its contents returned to the abdominal cavity — and the neck clamped, preparatorily to excising the sac beyond the clamp; b, the semicircular flap has been replaced and sutured.

Finally, the semicircular flap of skin and connective tissue is dropped back into position and sutured (Fig. 3372).

OPERATION FOR THE RADICAL CURE OF UMBILICAL HERNIA BY MEDIAN VERTICAL ELLIPTIC INCISION, FOLLOWED BY THE MEDIAN APPROXIMATION OF THE RECTI, AND THE VERTICAL OVERLAPPING OF THEIR OUTER APONEUROSES

Description.—This procedure largely resembles, in so far as the method of closure is concerned, the closure of an ordinary median abdominal section, where the inner margins of the exposed recti muscles are sutured, and their outer aponeuroses freed and overlapped. The hernial sac and its contents are dealt with as in the other methods of operating for the radical cure of umbilical hernia. The indication for the method may be considered to be an intermediate grade of hernia. In proportion as there has been a diastasis of the abdominal muscles, will their inner borders be found correspondingly apart.

Operation.—The incision begins in the median line, above the hernia, ends in the median line, below the hernia — the tumor itself being surrounded by an elliptic deviation of the median cut to each side just sufficiently to embrace its neck. The incisions are deepened to the aponeuroses — and, still deepening the incision carefully, the abdominal cavity is entered above or to one side of the hernia (as adhesions are more apt to be encountered below the sac). When once within the free peritoneal cavity, and the neck of the sac is determined by sweeping a finger around it, the elliptic incision can then be safely completed upon one side — and the tumor thrown over to the opposite side — which will reveal the opening of the sac and its engaged contents. An incision is made into the sac, from the cut margin, with blunt-pointed scissors

(Fig. 3373) _ the contents freed and returned to the abdomen, after the ligation and excision of any involved omentum. The omentum which may have entered the sac is, if adherent, best ligated and divided before incising the sac _ as it both gives room for further manipulations and avoids time and hemorrhage in the useless separation of the portion adherent within the sac _ the excised portion being removed still adherent within the sac. Finally, with the sac empty, the excision of the empty sac, with attached skin and connective

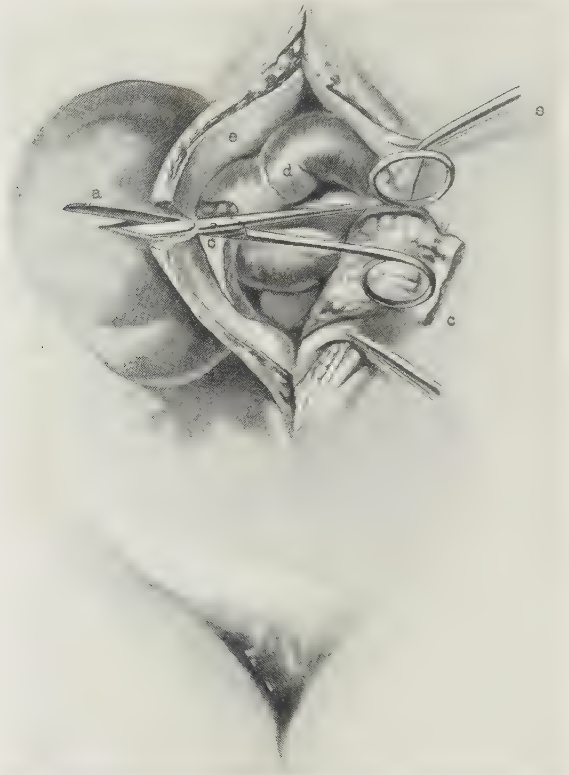


Fig. 3373.—Operation for the Radical Cure of Umbilical Hernia, Followed by the Median Approximation of the Recti, and the Vertical Overlapping of Their Aponeuroses _ I: _ Incising the sac of the umbilical hernia, after the abdomen has been opened upon one of its vertical aspects _ for the purpose of freeing its contents: _ **a**, Incising the sac, one blade of the scissors being upon the cutaneous, **a**, and the other, upon the peritoneal, **e**, aspect of the sac; **c**, **c**, the divided omentum, which should be first doubly ligated. The distal portion of the omentum is, here, adherent to the sac; **d**, coils of small intestine being withdrawn from the sac _ first freeing them, if adherent. (Figs. 3373 and 3374 modified from Guibe.)

tissue, is readily accomplished, by carrying the incision, by knife or scissors, along the opposite side of the ellipse (Fig. 3374).

Preparatorily to closing the wound thus left the inner margins of the recti are now freely exposed by slitting them up with sharp-pointed scissors _ wherever raw muscle borders are not already opened up by the original incisions _ the technic with scissors is shown in Fig. 3374. This division of the still undivided portion of the rectal sheath will enable the external layer of the sheath to be separated, by blunt dissection, from the outer surface of each rectus, for a distance of from 1 to $2\frac{1}{2}$ cm. ($\frac{6}{16}$–1 inch) from their border, according to the amount of overlapping indicated as necessary.

From this point on the closure is effected in the same manner as described and pictured under Median Abdominal Section Closed by the Overlap Method, pp. 111–121. The peritoneum is sutured with No. 1 plain catgut. Next, the subserous areolar tissue, transversalis fascia, and rectus of one side are sutured, as one tier, to the corresponding structures of the opposite side, by simple interrupted kangaroo-tendon sutures. The external aponeuroses of the two recti are then overlapped by the Reverdin needle technic (p. 115), by a single row of mattress-sutures of kangaroo-tendon, followed by a row of simple marginal sutures. The subcutaneous connective tissue, if thick, is closed with a tier of buried gut sutures — and the skin, with silkworm filament.

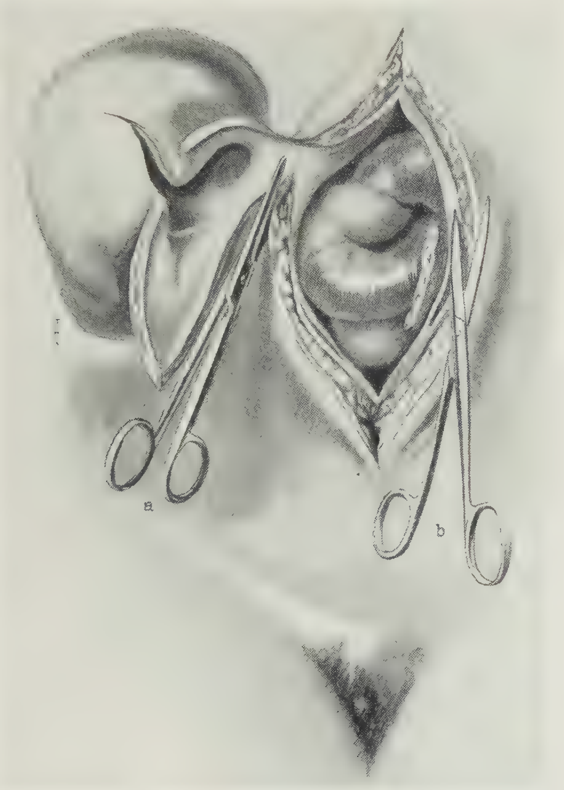


Fig. 3374.—The Same — II: — a, Completion of the excision of the sac; — b, splitting the aponeurosis of the inner margin of the left rectus muscle — which will be similarly accomplished upon the opposite side. The aponeuroses will then be overlapped in a vertical axis.

Dressing is applied, held by broad strips of zinc-oxid plaster — reinforced by an abdominal supporter.

Comment.—Silver-wire network or filagree reinforcement was formerly quite extensively employed — and still is, to some extent — to strengthen the hernial site against further protrusion — especially in those cases where the available muscular and aponeurotic tissue of the neighborhood is not, for some reason, adequate to do so. In such a procedure as the one mentioned above — and after suturing as there described, up to that level — the wire mattress is placed over the sutured recti – between them and their outer aponeurosis – which is then sutured over the wire-work, and the rest of the wound closed as usual. In many instances these silver filagrees remain long quiescent – but sooner or later they are very apt to give trouble and require removal. The writer has removed several (generally having no knowledge of their presence in advance) – and can answer for the difficulty of removal – and especially for the greater difficulty of then finding available sound tissue for a satisfactory closure. The method of using the wire network is shown in Fig. 3375.

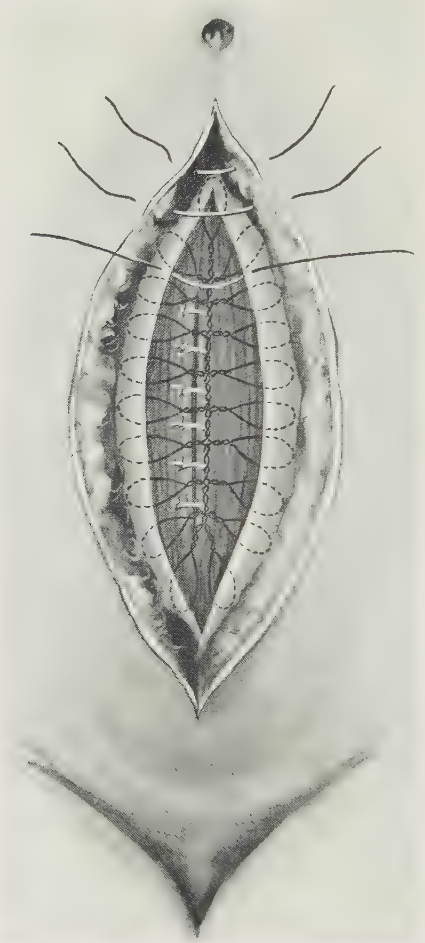


Fig. 3375.—Reinforcement of the Abdominal Wall, Following Operation for Umbilical Hernia, by the Implantation of a Wire Mattress Between the Sutured Recti and the Outer Rectal Sheaths, Which are Then Sutured Together Over It.

OPERATION FOR THE RADICAL CURE OF UMBILICAL HERNIA BY EXCISION OF THE SAC AND TRANSVERSE OVERLAPPING OF THE ABDOMINAL APONEUROSES

MAYO'S TECHNIC

Description.—The hernial sac, together with the redundant tissues covering it, is excised by a transversely placed elliptic incision _ after which the abdominal aponeuroses bordering upon the ring are overlapped transversely by broad surfaces _ the upper flap (from which the peritoneum has been displaced) overriding the lower flap. W. J. Mayo especially employed the method in large umbilical herniæ, where it was impossible to close the opening with muscles.

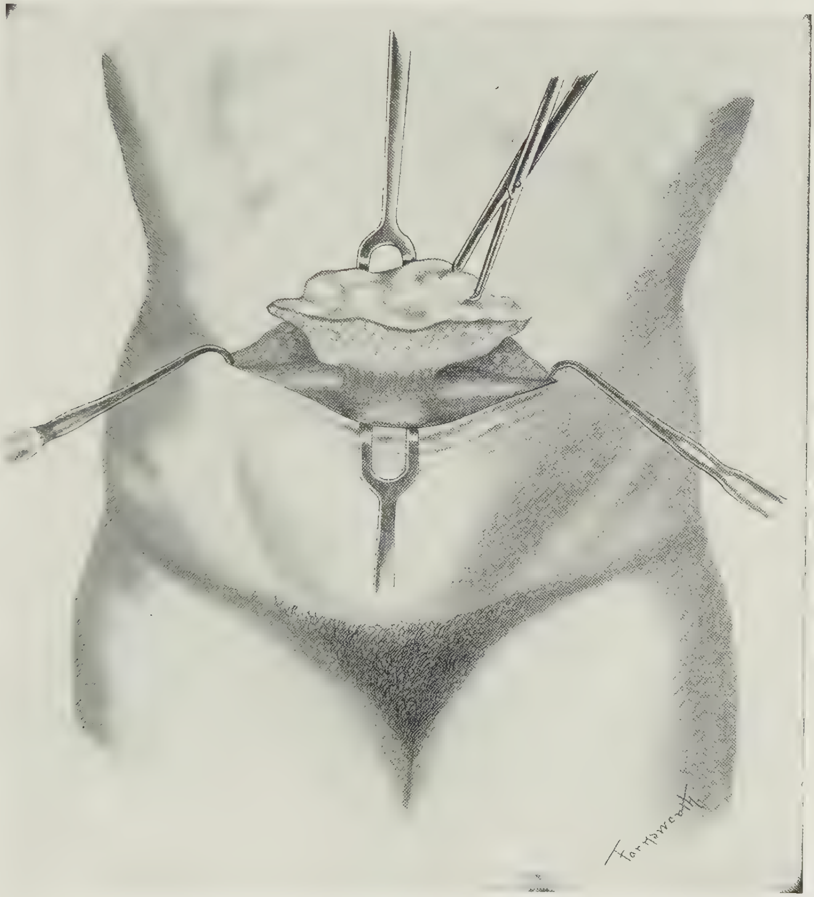


Fig. 3376.—Mayo's Operation for the Radical Cure of Umbilical Hernia as Originally Performed; _ Clearing the neck of the hernial sac.

Preparation.—As for median abdominal section.

Position.—Patient supine, at edge of table. Surgeon to patient's right. Assistant opposite.

Landmarks.—Site and form of the hernia; umbilicus; median line.

Anesthesia _ Analgesia.—The former is usually employed. In Fig. 3369 the sites are shown where novocain solution is injected when analgesia is used.

Incision.—The incision begins and ends directly to the sides, and about 2.5 cm. (1 inch) or more from the base of the hernial tumor _ separating into two limbs to form the ellipse which embraces the neck of the hernia near its junction with the abdominal wall. The maximum separation of the limbs of the ellipse will be opposite the greatest width of the hernia, and will be determined by the size of the tumor.

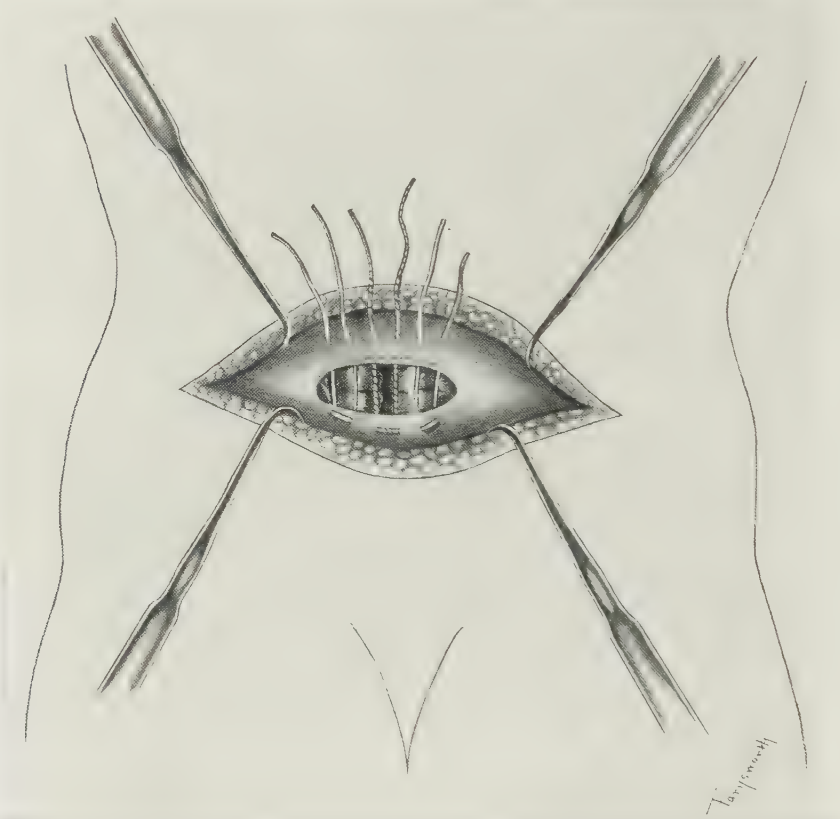


Fig. 3377.—Mayo's Operation for the Radical Cure of Umbilical Hernia _ II; _ Suturing of the margins of abdominal aponeuroses and muscles, mattress-sutures of Pagenstecher thread in the center and of chromic catgut laterally.

Operation.—The incisions are at first deepened down to the aponeuroses (Fig. 3376) _ after which the overlying soft parts are well retracted from the aponeurotic structures, away from the hernia _ to the extent of 5 or 7.5 cm. (2½ or 3 inches). Bleeding is controlled by clamp and ligature. Exercising care, and selecting a site along the elliptic incision where it seems likely the cut will not encounter adhesions, the incision is deepened through aponeuroses and peritoneum, into the abdominal cavity. Once this is entered, it is easy to sweep the finger around the structures protruding into the hernial sac _ and thus safeguard them in the further steps of excising the sac _ the Surgeon's left index within the abdomen, preceding the scissors (or underlying the knife). The hernial sac may be thus entirely excised by the progressive sweep of scissors or knife _ especially if, in the manipulation, its contents slip back into the abdominal cavity. It is often found convenient, however, after freeing one aspect of the sac, to guardedly cut through its constricted neck _ by knife from without or blunt-pointed scissors from within _ after which the intestinal contents of the sac are freed and returned to the abdomen, and the omentum ligated and excised (if attached to the sac, from which no attempt is made to detach it). If intestines be adherent to the wall of the sac, they are carefully separated. As the sac is to be discarded, if very firm adhesions exist, they may be detached at the expense of slicing off a limited and thin portion of the sac and leaving it attached to the intestinal coil.

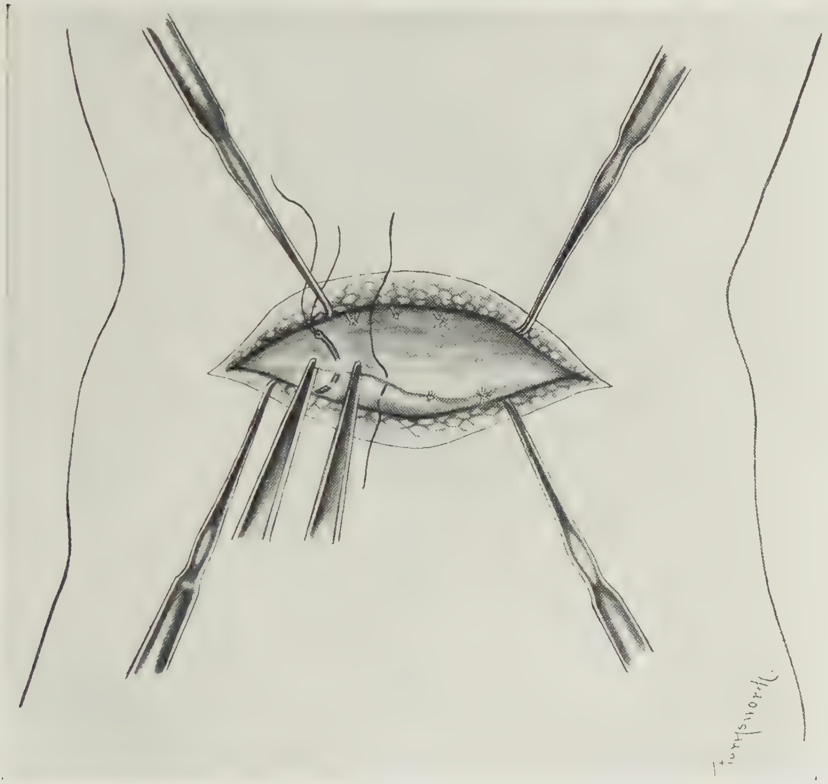


Fig. 3378.—Mayo's Operation for the Radical Cure of Umbilical Hernia _ III; _ Overlapping of the aponeuroses, accomplished by the preceding tier of sutures, after which the free edge of the upper margin of aponeuroses is stitched to the surface of aponeuroses of the lower aspect of the wound

The entire sac, with the umbilicus and the coverings included in the ellipse, is now excised _ dividing the peritoneum in an elliptic manner about the neck of the sac. The excision of the sac usually leaves an opening somewhat more oval than one with pointed lateral ends. It is to be remembered that in these cases the inner margins of the recti muscles are often considerably separated _ and that the interrectal tissues may be exceedingly thin _ consisting.

practically, of skin, thinned fascia, stretched aponeuroses between the recti, little or no subserous areolar tissue, and peritoneum.

The peritoneum is now separated from the under surface of the upper flap _ so that the lower flap may be dovetailed between the aponeuroses and peritoneum of the upper flap. (See Comment.)

All is now ready for the applications of the mattress-sutures through which the overlap is accomplished _ and these are much more conveniently and rapidly applied with the Reverdin needle. These are placed in two tiers. The method of placing the first tier and the method of their tightening is shown in Fig. 3377 _ and the second tier, and their tightening, in Fig. 3378. The first tier of sutures pass through the upper flap about 5 to 6.3 cm. (2–2½ inches) above its border, but not through the peritoneum which was detached from it _ and pass just below the margin of the lower border, with its peritoneum undisturbed. By traction upon these first mattress-sutures the parts are sufficiently approximated (while still sufficiently far apart for manipulation) to enable the margins of peritoneum to be sutured by a few interrupted sutures

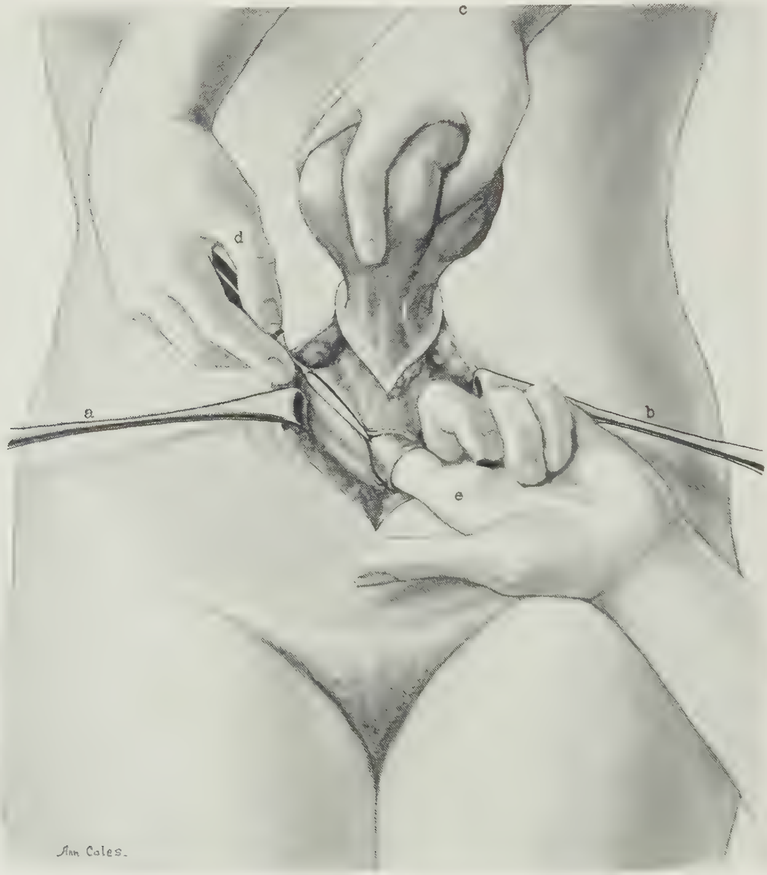


Fig. 3379.—Mayo's Operation for the Radical Cure of Umbilical and Paraumbilical Hernia as Usually Performed _ I; _ The base of the sac has been exposed by an encircling vertically placed elliptic incision _ and the neck of the sac is being excised in the transverse axis of the body. A finger within the peritoneal cavity is protecting the intestines from possible injury

passed between the mattress-sutures. The mattress-sutures are of silk, Pagenstecher, kangaroo-tendon, or chromic catgut. When the first sutures are tied, the lower flap is dovetailed between the peritoneum and aponeurosis of the upper flap. The second tier of chromic gut sutures simply tacks, by ordinary stitch, the free margin of the upper flap to the surface of the lower flap.

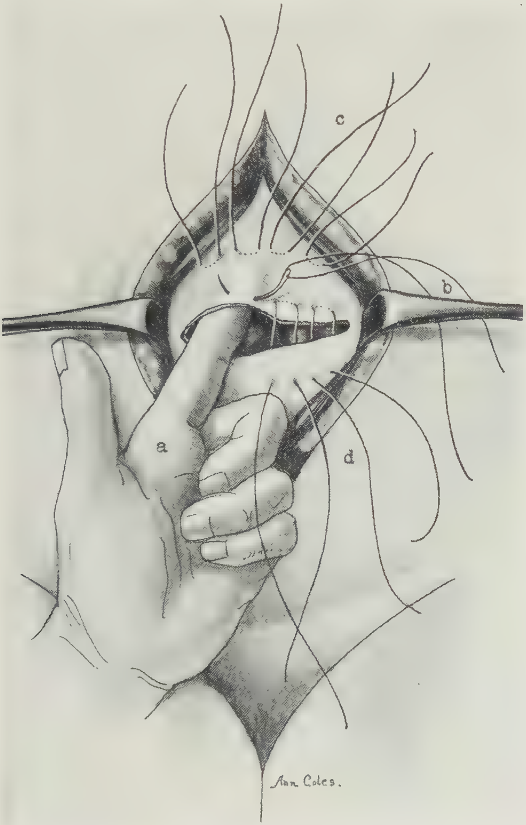


Fig. 3380.—The Same _ II: _ **b**, The loops of the first tier of mattress-sutures _ here placed with an ordinary needle _ have been carried through the upper lip of the wound, near its margin _ and their free limbs, out through the lower lip of the abdominal muscles and aponeuroses, at some distance from its margin, at **d** _ a finger, **a**, protecting the intestines during the passage. Tying of these sutures will cause the lower lip to overlap the upper lip. The loops of the second tier of sutures, **c**, have been carried through the upper or overlapped lip of the wound, at some distance from its border _ and will be passed through the margin of the lower, or overlapping lip, aftet the first tier is tied. The lower lip will thus overlap the upper lip. The reverse method is sometimes employed _ the upper lip overlapping.

The connective tissue, especially if thick, is united by buried catgut sutures _ and the skin, by silkworm filament.

A firm abdominal support should reinforce the dressing. The patient remains in bed from twelve to twenty days.

Comment.—The overlap type of operation may be regarded as the best surgical procedure for the radical cure of umbilical hernia.

The hernia is often exposed and the sac excised by an elliptic incision placed in the long axis of the body _ after which the overlapping is done transversely, as above described.

Freedom of manipulation is greatly enhanced by the early opening of the sac.

The detachment of the peritoneum from the upper flap, and the separate suturing of the peritoneum, are now often omitted.

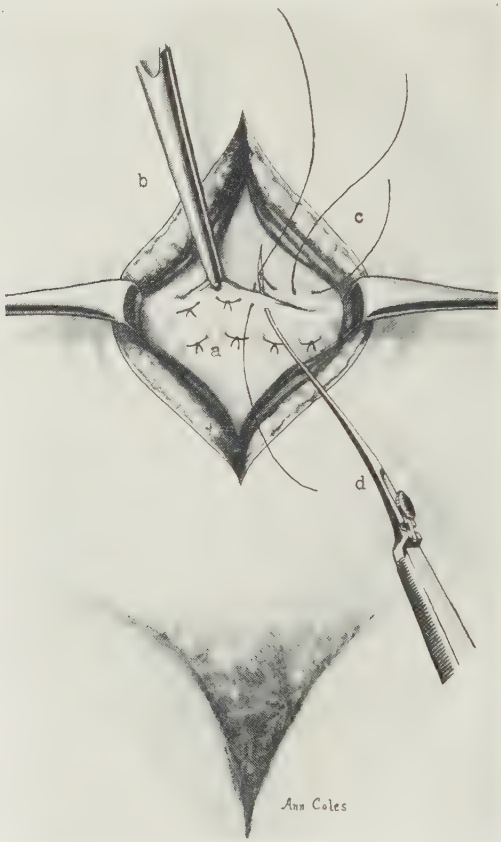


Fig. 3381.—The Same – III; – The first tier of mattress-sutures, approximating the margin of the upper lip to the surface of a distant portion of the lower lip, have been tied. The second tier – here carried by a Reverdin needle – are approximating the surface of the upper or overlapped lip, to the margin of the lower, or overlapping lip.

Mayo's operation, as usually performed at present, is shown in Figs. 3379–3381.

OPERATION FOR THE RADICAL CURE OF UMBILICAL HERNIA BY EXCISION OF THE SAC AND VERTICAL OVERLAPPING OF THE ABDOMINAL APONEUROSES

BLAKE'S TECHNIC

The general principles involved in the Blake operation are the same as those in the Mayo procedure, in so far as reinforcement of the weakened region by overlapping of the abdominal aponeuroses is concerned – but, in Blake's technic, the incision of approach is made vertically, and the overlapping of the aponeuroses is from side to side.

The method is of especial application to those cases in which the linea alba is considerably stretched, with a corresponding diastasis of the inner margins of the recti muscles _ both of which the vertical overlapping corrects.

The median line is incised above and below the tumor _ with the surrounding of the neck of the sac by a bilateral broadening of the median incision, in elliptic fashion. The hernial sac is opened, cleared and excised, with or without the ring. One side of the abdominal wall is then drawn over the opposite side _ the ventral surface of one side being thus applied to the outer or aponeurotic surface of the other.

If indicated, a strip of linea alba may be excised. It is necessary to carefully remove all areolar tissue from the aponeurotic surface (the rectal sheath) of the flap to which the posterior aspect of the opposite rectus is to be applied _ which may be accomplished by sharp and blunt dissection, and by gauze rubbing.

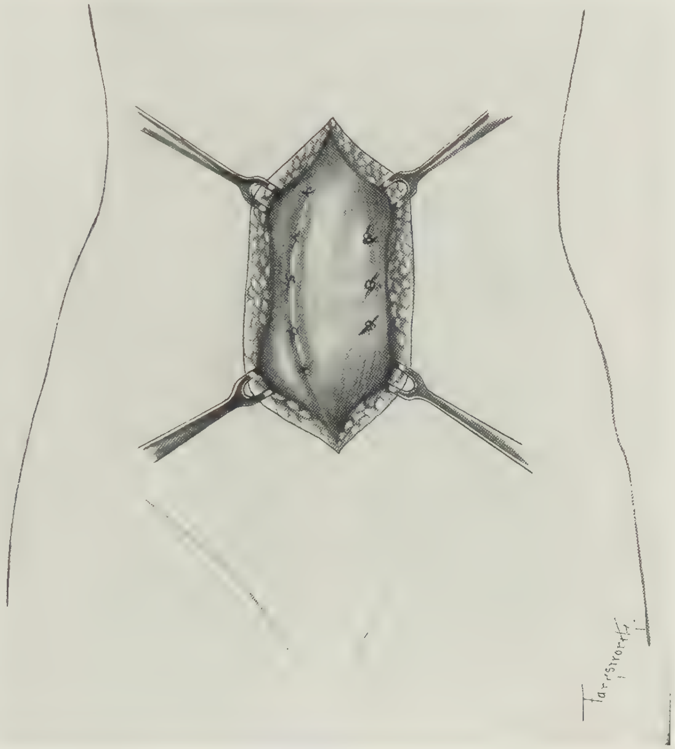


Fig. 3382.—Blake's Operation for the Radical Cure of Umbilical Hernia; _ Showing a vertical division of the parts and overlapping of the aponeuroses. (The scale of operation is here represented somewhat too large.)

In placing the mattress-sutures (which is quickly and conveniently done with a Reverdin needle) the stitches are so placed that they will run with the muscle-fibers, and not cause their strangulation by crossing them.

Calculation should be made, during the placing of the stitches, that the parts will lie in even and flat apposition where the flaps converge, above and below.

It is also well to so plan the mattress-sutures as to snugly approximate the free edge of the overlapped flap to the surface of the overlapping flap _ to avoid, as far as possible, adhesions of the raw edge within the abdominal cavity. Finally, the edge of the overlapping flap is tacked down to the surface of the overlapped flap by ordinary interrupted sutures.

The peritoneum is sutured with No. 1 plain catgut _ and the aponeuroses and muscles, with No. 2 chromic gut.

The size of the redundant abdominal wall is thus also often appreciably and helpfully lessened.

The sutured, overlapped flaps are shown in Fig. 3382.

RADICAL OPERATION FOR COMBINED UMBILICAL HERNIA AND MARKED DIASTASIS OF THE RECTI MUSCLES

LEXER'S TECHNIC

Description.—In these instances not only is some degree of umbilical hernia present, but the inner borders of the recti muscles have become separated from each other for a considerable extent _ the separation extending both above and below the site of hernia. The feature of the operation consists in the method of suturing.

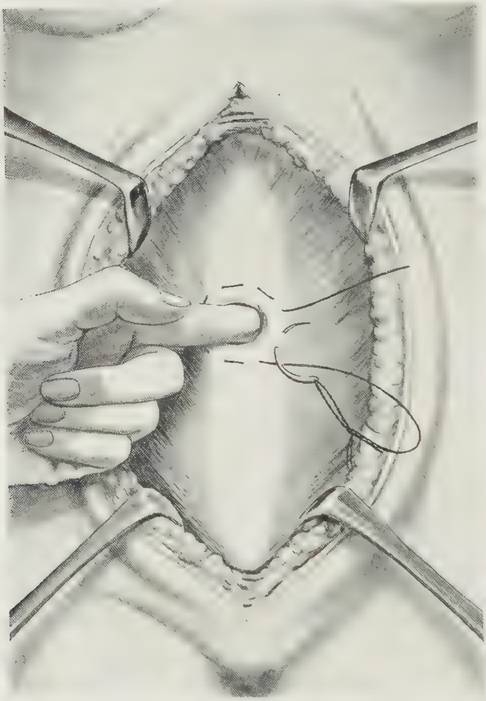


Fig. 3383.—Radical Operation for Combined Umbilical Hernia and Marked Diastasis of the Recti Muscles _ Lexer's Technic _ I; _ The hernial sac has been excised, and the tobacco-pouch suture is being placed around the umbilical ring.

Operation.—An incision is made in the middle line over the linea alba, beginning as far above, and ending as far below the hernia as indicated by the diastased borders of the recti _ and diverging to form a narrow ellipse which embraces the hernial protrusion. The hernial sac is exposed in the usual way, and carefully opened _ after which its contents are freed and returned to the abdominal cavity, and the sac excised. The hernial ring is not resected.

A tobacco pouch-suture is next introduced, circumventing the hernial opening – for the purpose of puckering together the hernial ring and the tissues immediately adjacent to the borders of the ring. This is accomplished by the introduction of the Surgeon's left index-finger through the hernial ring, into the free peritoneal cavity (Fig. 3383) – to safeguard the intra-abdominal structures, while he places a purse-string suture of aluminum-bronze wire in and out through the structures of the abdominal wall intervening between fascia and peritoneum, but not penetrating into the peritoneal cavity. This suture will pass through the inner borders of the recti, on the sides, and through the stretched aponeuroses, in the middle. Before tightening this suture the peritoneum and fascia are sutured together in the ordinary manner. The aluminum-bronze suture is then tightened and fastened – thereby inverting the borders of the umbilical ring and the structures immediately adjacent.

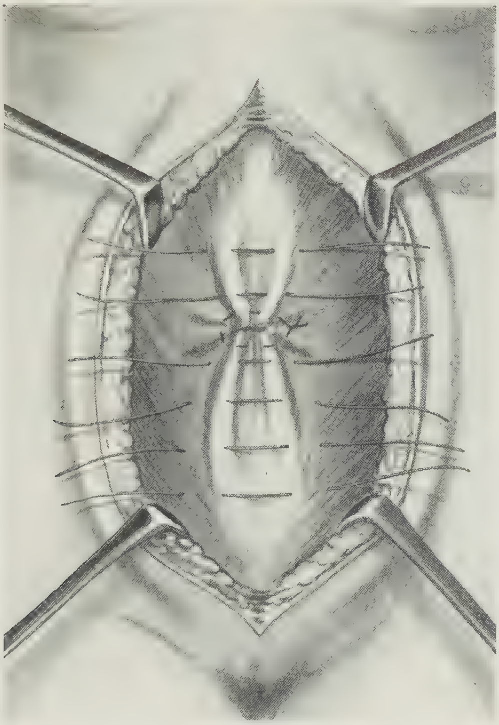


Fig. 3384.—The Same – II; – The aluminum-bronze purse-string suture has been twisted and cut – and the transverse sutures, of the same material, have been passed through the inner borders of the recti and their aponeuroses, preparatorily to inverting the median portion of the stretched aponeurotic structures and approximating the borders of the recti.

Interrupted aluminum-bronze wire sutures are, finally, placed transversely at intervals, above and below the umbilical opening, as far, in either direction, as may be indicated, to re-approximate their diastased borders (Fig. 3384). These enter the aponeurosis over the inner aspect of each muscle – take a good hold upon the muscle substance – and emerge through the aponeurosis upon its inner aspect – after which the stitch passes over to the opposite side, in the open – and is carried through the corresponding structures, in the reversed order. Care, of course, is exercised that they nowhere enter the abdominal cavity. When all have been placed, and while the structures are held together, so as to take the strain off the stitches, each suture is fastened in turn, thus inverting the opposite borders of the recti and the intervening aponeurosis — the twisted ends being cut, and so fashioned and bent as not likely to wound the soft parts, or serve as sources of irritation.

If the fascia is thick, it is brought together with a tier of buried sutures. The skin is closed with silkworm suture.

Comment.—It would seem safest and best to place all the sutures to approximate the rectal borders before closing the umbilical ring — or as many as possible. And in twisting the sutures better mechanical union would be accomplished by first twisting the transverse suture above and the one below the purse-string suture — and then the purse-string suture.

PLASTIC REPAIR OF THE ABDOMINAL WALL FOR RELATIVE HERNIA

COFFEY'S OPERATION

Description.—No absolute hernia exists in the present instance — in the sense that a part of the abdominal contents passes through and protrudes from an opening in the abdominal wall. But there may be a marked bulging, in asymmetric or symmetric fashion, of a considerable area of the weakened abdominal wall, between the umbilicus and the anterior superior iliac spine, caused by transverse stretching of the aponeurosis of the external oblique — sufficiently pronounced to constitute a relative hernia. A bilateral existence of this condition constitutes a pendulous belly. The object of the operation is to split the relaxed and bulged muscles and aponeuroses, representing the bulge — and to overlap and suture together surface to surface the resulting aponeuromuscular flaps — thereby lessening the extent of the redundant abdominal wall by the aggregate amount of overlapped flaps. In bilateral bulges the operation is performed upon both sides.

Operation.—In operating for bilateral abdominal bulges (Fig. 3385) the external oblique muscle and aponeurosis are split in their cleavage line — beginning as far posteriorly as the size and nature of the bulge necessitate — the incision being so planned as to correspond to, and converge with a similar splitting of the muscle and aponeurosis of the opposite external oblique at a point just above the symphysis pubis — the skin incisions having been planned to these ends. The split external oblique muscles and aponeuroses are then separated from the underlying internal oblique — the resulting flaps being retracted, respectively, upward and inward, and downward and outward.

The overlapping is accomplished by displacing the lower flap beneath the upper — and drawing the upper downward over the lower. This is accomplished by mattress-sutures — which are most rapidly and satisfactorily applied with a Reverdin needle. The first tier of sutures enter the base of the upper flap, along the line of uppermost separation from the underlying parts — and come out and double back upon themselves near to (but not including) the split border of the lower flap. When these are tightened, the border of the lower flap is drawn snugly up into the highest recess beneath the upper flap. It is of primary importance to remember that these sutures are placed in semi-elliptic contour (so as to complete the ellipse when the second tier is placed) — being furthest apart in the middle — and tapering at the two ends. These are all tied. The lower aspect of the upper flap is then sutured to the lower flap — by a corresponding tier of semi-elliptically placed mattress-sutures. After these are tied the free margin of the upper flap is tacked down to the surface of the lower flap by ordinary interrupted sutures — thus completing the suturing.

For ease, rapidity, and especially for safety (as to controlling the depth of penetration), if one be employing the Reverdin needle technic, it would be best to place the second tier of mattress-sutures through the lower flap (leaving their ends free), before tying the upper tier – after which the free ends are easily brought through the lower flap just within its lower border. The free margin of the upper flap is readily and safely tacked down to the surface of the lower flap by simple stitches.

Coffey subsequently added many more sutures, interruptedly placed, binding the two flaps together. It would seem that if any more mattress-sutures were needed, beyond the two already placed, that they are best placed as a symmetric middle tier, before any are tied.

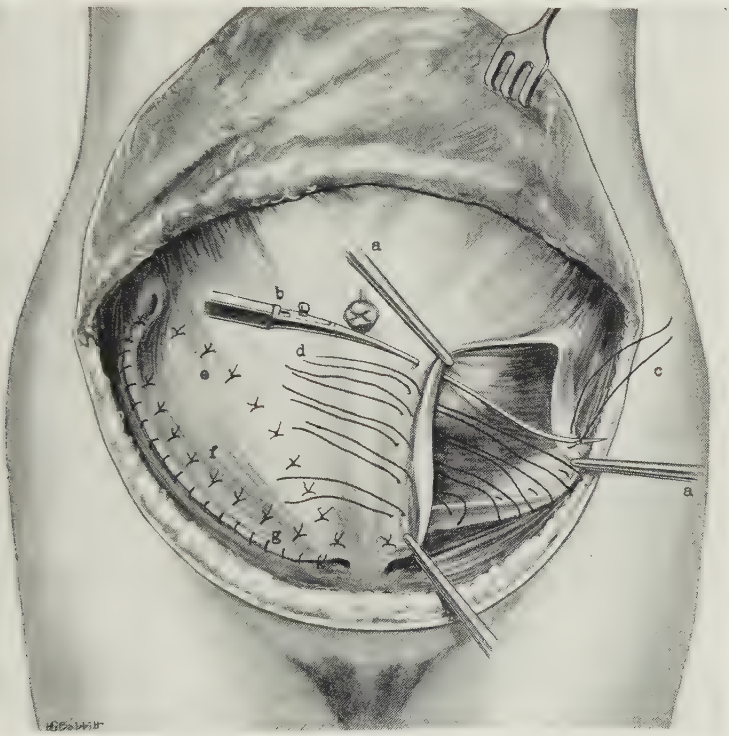


Fig. 3385.—Plastic Repair of the Abdominal Wall for Relative Hernia – Coffey's Operation: – **a, a,** Tractors of the split margins of the redundant external oblique; – **b, c,** Reverdin needle in the act of placing mattress-sutures at some distance from the split edges of the muscle; – **d,** these sutures drawn through, overlapping the inner upon (on top of) the outer portion of the external oblique; – **e,** the same sutures when tied; – **f,** row of sutures placed through the margin of the overlapped, outer portion of the external oblique, and emerging a short distance inside of the margin of the overlapping, inner portion of the internal oblique; – **g,** row of sutures uniting the free margin of the overlapping, inner part of the external oblique, to the surface of the overlapped, outer part of the external oblique.

Coffey employed linen thread – and cautioned that the loops of the sutures should include the fibers of fascia in a transverse direction. He finally sutured down the free margin with a continuous catgut suture.

The overlap must be accurately planned, so that the flaps will lie smoothly and the tension be everywhere equalized – especial attention being paid to the upper and lower points of convergence.

As a result of this procedure, the distance between the umbilicus and the anterior superior iliac spine is materially decreased on both sides – the rotund protrusion is obliterated – and the fascial wall is doubled, and its resistance thereby greatly increased.

The fascial plane is separately closed by buried catgut sutures, if necessary – and the skin, by silkworm sutures. The abdominal wound is substantially supported by dressing and abdominal binder.

RADICAL OPERATION FOR LATERAL VENTRAL HERNIA

MAYO TECHNIC

Description.—This type of hernia is usually a postoperative occurrence – that is, it is usually the sequence of some intra-abdominal operation – where,

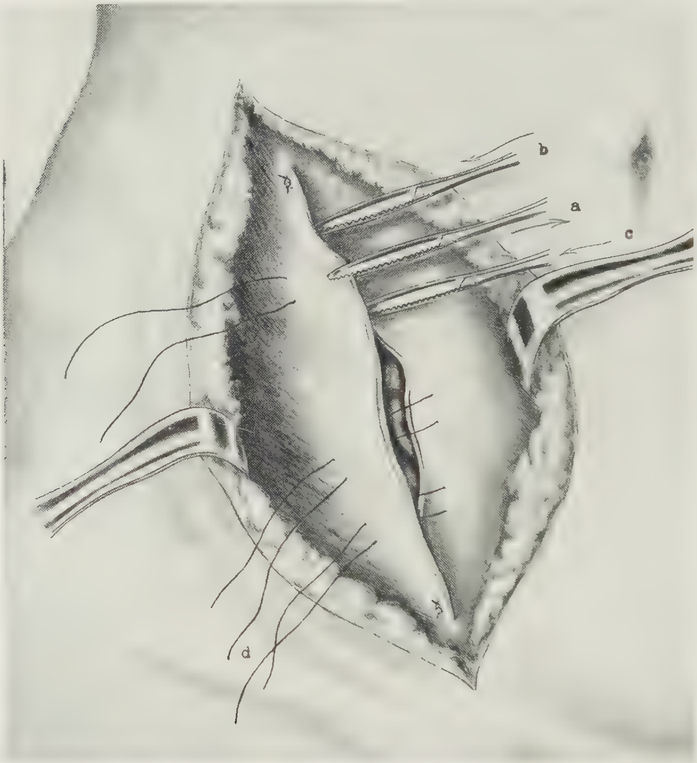


Fig. 3386.—Radical Operation for Lateral Ventral Hernia – Mayo Technic – I; – Placing the first tier of mattress-sutures between the pedicle of the overlapping composite flap (of all the soft parts from fascia to peritoneum, including both) and the outer aspect of the overlapped flap, near to and parallel with the margin of the latter: **d,** The mattress-sutures, loose; **b** and **c,** clamp-forceps pushing the free margin of the internal oblique under the overlapping external oblique flap, which the clamp-forceps, **a,** is, in turn, drawing outward – thus insuring a substantial overlap – this latter not being a part of the Mayo technic.

either the wound united primarily, but where some step of the technic was imperfect and the scar yielded, – or where drainage had been employed, – or where suppuration occurred in the course of healing, – or where important anatomic structures had to be sacrificed during operation. Every care should be taken to plan and conduct the original operation so that postoperative hernia will not be likely to follow.

Where the originating cause of the hernia was a median operation, the hernia is, of course median _ and will differ in no essential respect from the herniæ of the median line _ which have already been considered. The operation for a laterally placed ventral hernia will be here considered as applied to hernia through an old appendicectomy wound.

Operation.—It would be ideal if the anatomic structures involved in the hernial opening could be exposed _ and rejoined in their normal relationships _ peritoneum to peritoneum _ aponeuroses to aponeuroses _ and muscles to muscles _ after having removed all scar-tissue. Unfortunately, however, the very conditions which have produced and perpetuated the hernia, have often so vitiated the structures which might otherwise be used for repair _ by sloughing, atrophy, retraction, and the like _ that such ideal steps cannot be taken _ as intact layers are often not present to be thus manipulated.

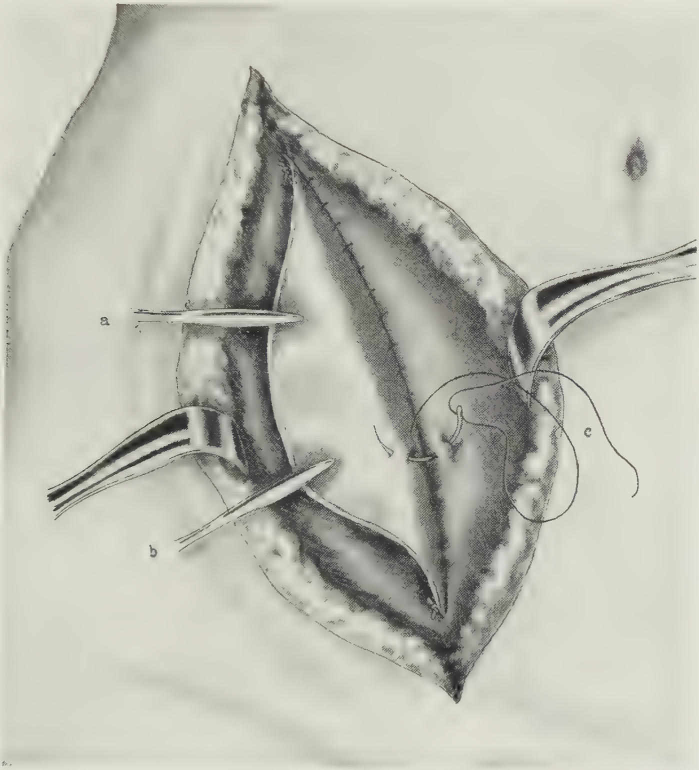


Fig. 3387.—The Same _ II; _ The second tier of continuous suturing, **c**, uniting the peritoneum of the overlapping flap, **a**, **b**, to the aponeurosis of the overlapped flap.

In such cases it has been found that the massive overlapping of the several constituent layers of the abdominal wall has been followed by excellent result. Composite autoplastic flaps consisting of peritoneum, muscle, fascia, and scar-tissue, as the case may be, in one flap, is made to overlap a similar flap of the corresponding layers of the other side _ in such a way that the peritoneum of one flap is superimposed upon the aponeurosis and scar-tissue of the other flap. In other words, one flap bodily overlaps the other _ so that the structures of the abdominal wall are doubled at the site of overlap. The details of this overlapping will be determined by conditions of the special case – and may be from side to side, or from above downward, or obliquely – and either flap may be the outer one.

The steps of the procedure are as follows: – (*a*) The skin-scar is excised. (*b*) The hernial opening is exposed. (*c*) The fatty areolar tissue is cleared from the muscular aponeuroses for 5 cm. (2 inches) all around the hernial opening. (*d*) The neck of the hernial sac is freed from the hernial opening. (*e*) The hernial sac is incised, and any adhesions of its contents which exist are freed for at least 2.5 cm. (1 inch). (*f*) The most convenient manner of overlapping the flaps is chosen – so that the peritoneal surface of one flap will lie upon the aponeurosis of the other. No scar-tissue and no excessive tissue of any kind is sacrificed – except fatty tissue. (*g*) Several strong mattress-sutures of chromic catgut, or linen are passed through the pedicle of the upper (overlapping) flap – and thence through the lower (overlapped) flap, near to, and parallel with, its free margin – Fig. 3386. (*h*) When this layer of mattress-sutures has been placed and tied, the outer flap is held upward, while the peritoneum of this overlapping flap is being stitched, with continuous suturing, to the aponeurosis of the overlapped (inner) flap – thus securely shutting off the peritoneal cavity (Fig. 3387). (*i*) The free margin of the overlapping flap is stitched, by continuous suturing, to the surface of the overlapped flap – the peritoneum of the former to the aponeurosis of the latter (Fig. 3388).

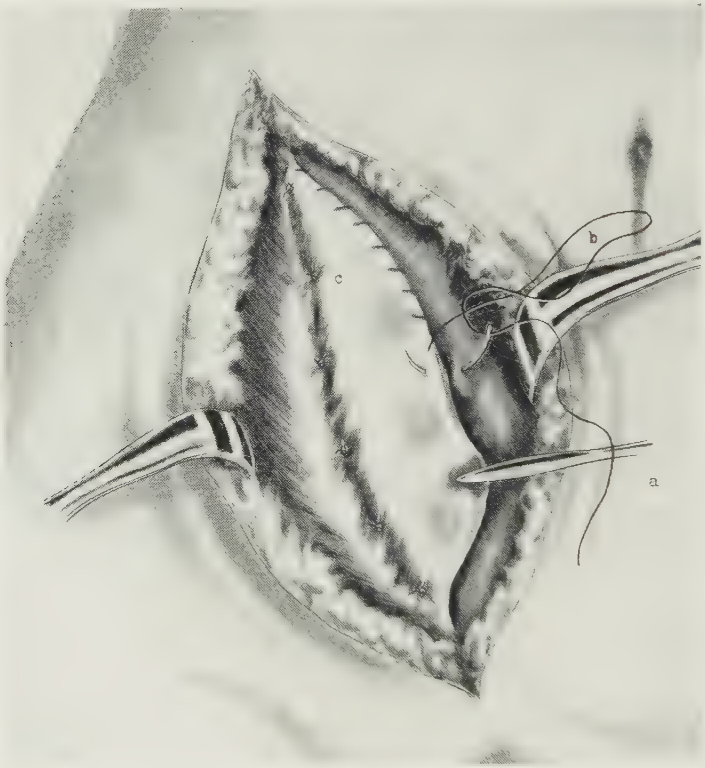


Fig 3388.—The Same – III; – Tacking down, with a continuous suture, b, the free margin of the overlapping composite flap, c and a, to the aponeurosis of the overlapped flap.

(*j*) The skin and fascial planes are closed by one or two tiers of suturing, according to their thickness. If there be much serous, or fatty ooze, temporary drainage is established, either through an end of the wound or by a stab-drain.

The patient remains in bed for from fifteen to eighteen days. Where the abdomen is heavy, a general abdominal support is worn _ but one which makes no direct pressure at any point.

INGUINAL HERNIA

SURGICAL ANATOMY

The structures encountered in the operations for inguinal herniæ and those in the immediate neighborhood of the site of operation, will be here briefly described _ chiefly in the order encountered, from without inward.

Superficial Fascia.—Divisible into two layers, between which lie superficial arteries, veins, lymphatics, and nerves of the inguinal region.

Superficial Layer of Superficial Fascia.—Continuous with superficial fascia of abdomen, thigh, penis, scrotum, labia, and perineum.

Superficial Arteries.—Superficial epigastric branch of femoral. Superficial circumflex iliac of femoral. Superficial external pudic of femoral.

Superficial Veins.—Accompany arteries and end in internal saphenous vein.

Superficial Lymphatics.—Superior group, along Poupart's ligament. Inferior group, around saphenous opening.

Superficial Nerves.—Hypogastric branch of Iliohypogastric, Ilio-inguinal.

Deep Layer of Superficial Fascia (Scarpa's Fascia).—Attached to linea alba _ continuous with superficial fascia over trunk _ cinnected with fascia lata _ helps form dartos _ continuous with deep layer of superficial fascia of perineum.

External Oblique Muscle.

Poupart's Ligament.—That portion of aponeurosis of external oblique extending from anterior superior iliac spine to spine of os pubis.

Gimbernat's Ligament.—That portion of aponeurosis of external oblique which is reflected from Poupart's ligament, at spine of os pubis, along the pectineal line.

Triangular Ligament.—That portion of aponeurosis of external oblique which is reflected from Gimbernat's ligament, at the pectineal line, upward and inward beneath the spermatic cord and behind the internal pillar of the external ring and in front of the conjoint tendon, to the linea alba, where it interlaces with its fellow of opposite side.

External or Superficial Abdominal Ring.—A triangular opening in aponeurosis of external oblique immediately above and just external to crest of os pubis. Bounded, inferiorly, by crest of os pubis, _ Superiorly, by intercolumnar fibers, strengthened by intercolumnar fascia, _ Internally, by inner or superior pillar, _ Externally, by outer or inferior pillar. Transmits spermatic cord in male, and round ligament in female.

Internal Oblique Muscle.

Conjoint Tendon of Internal Oblique and Transversalis.—Inserted into crest of os pubis and pectineal line, directly behind external abdominal ring.

Cremaster Muscle.—Corresponds with inferior fibers of internal oblique _ arising from center of Poupart's ligament, where they are continuous with the interno-inferior aspect of that muscle _ descend along external and anterior aspect of spermatic cord _ curve around testicle _ and, ascending along inner aspect of cord, are inserted into crest of os pubis and anterior surface of sheath of rectus. The fascia cremasterica increases the strength of these fibers.

Transversalis Muscle.

Transversalis Fascia.

Inguinal Canal.—Transmits spermatic cord in male _ and round ligament in female. Extends obliquely downward and inward for about 3.8 cm. (1½ inches) _ parallel with and slightly above Poupart's ligament _ beginning at the internal abdominal ring and ending at the external abdominal ring. Anterior boundaries, _ skin; superficial fascia; aponeurosis of external oblique (throughout); internal oblique (outer third). Posterior boundaries, _ triangular ligament; conjoint tendon of internal oblique and transversalis; transversalis fascia; subperitoneal fat; peritoneum. Superior boundaries, _ curved fibers of internal oblique and transversalis. Inferior boundaries, _ junction of fascia transversalis and Poupart's ligament.

Internal or Deep Abdominal Ring.—An oval opening lying in the transversalis fascia, half-way between the anterior superior iliac spine and symphysis pubis, and about 1.3 cm. (½ inch) above Poupart's ligament. Superior and External boundary, _ curved fibers of transversalis. Inferior and Internal boundaries, _ deep epigastric vessels. Transmits spermatic cord in male _ and round ligament in female. Infundibuliform process of fascia transversalis strengthens its opening.

Subperitoneal Areolar Tissue.

Deep Epigastric Artery of External Iliac.

Other anatomic points, necessary to the thorough understanding of the Inguninal Herniæ, are given under General Surgical Considerations.

GENERAL SURGICAL CONSIDERATIONS IN OPERATIONS FOR INGUINAL HERNIÆ

Definition of Inguinal Hernia.—Hernia passing through the abdominal wall in the inguinal region.

Varieties of Inguinal Herniæ.—(1) External or Oblique Inguinal Hernia, _ neck of sac lies external to deep epigastric artery, _ follows course of spermatic cord through inguinal canal. (2) Internal or Direct Inguinal Hernia, _ neck of sac lies internal to deep epigastric artery, _ hernia penetrates some portion of abdominal wall internal to deep epigastric artery.

(*a*) **Oblique or External Inguinal Hernia.**

Coverings of Oblique Inguinal Hernia.—The hernia enters the external inguinal fossa (v. i.) _ and, passing down from the abdominal cavity, receives the following coverings, in order: _ (1) At Internal Abdominal Ring: _ peritoneum; subserous areolar tissue; infundibuliform process of fascia transversalis; (2) In Inguinal Canal: _ (passes under curved fibers of internal oblique and transversalis, but does not receive a covering from them); cremaster muscle; _ (3) At External Abdominal Ring: _ intercolumnar fascia; _ (4) In Scrotum: _ superficial fascia; skin.

Position of Oblique Inguinal Hernia.—This variety of Inguinal Hernia always lies to the outer side of the deep epigastric artery _ and generally lies anterior to the vessels of the spermatic cord _ and rarely descends below the testis (because of adhesion of the hernial coverings to the tunica vaginalis).

Seat of Stricture in Oblique Inguinal Hernia.—Most frequently at the internal ring, _ may occur at the external ring, _ or may occur in the canal, by fibers of internal oblique and transversalis.

(*b*) **Direct or Internal Inguinal Hernia.**—A correct understanding of this form of hernia depends upon a knowledge of the anatomy of the lower abdominal wall.

Cord-like Structures Upon Inner Aspect of Lower Abdominal Wall.—Seven cord-like structures are seen upon the inner aspect of the lower abdominal wall _ ranging from near the median line upward: _ (*a*) Plica Urachi _ remains of fetal urachus in median line; _ (*b*) Two Plicæ Hypogastricæ _ obliterated hypogastric arteries on each side of median line, running upward toward the median line; _ (*c*) Two Plicæ Epigastricæ _ deep epigastric arteries running upward and toward median line; _ (*d*) Two Poupart's Ligaments _ running upward and outward.

Fossæ Upon Inner Aspect of Lower Abdominal Wall.—Eight fossæ are formed by the peritoneum stretched over these prominent cord-like structures _ by the depressions between them: _ (*a*) Two Internal Inguinal Fossæ _ between plicæ urachi and plicæ hypogastricæ; _ (*b*) Two Middle Inguinal Fossæ _ between plicæ hypogastricæ and plicæ epigastricæ; _ (*c*) Two External Inguinal Fossæ _ between plicæ hypogastricæ and Poupart's ligaments; (*d*) Two femoral fossæ _ below Poupart's ligaments, to inner side of femoral vein.

Relations of Herniæ to Fossæ Upon Inner Aspect of Lower Abdominal Wall.—(1) Through the External inguinal fossa, an oblique inguinal hernia occurs; _ (2) Through either the Internal or Middle inguinal fossa, a direct inguinal hernia comes; _ (3) Through the Femoral fossa, a femoral hernia occurs.

Fossæ Within Hesselbach's Triangle Through which Direct Inguinal Hernia May Come.—Hesselbach's Triangle is bounded _ Externally; by deep epigastric artery; _ Internally; by outer border of rectus muscle; _ Inferiorly; by Poupart's ligament. The conjoint tendon of the internal oblique and transversalis is stretched across the inner two-thirds of Hesselbach's triangle. The remaining outer one-third has only the subperitoneal areolar tissue and transversalis fascia between the peritoneum and the external oblique aponeurosis. The plica hypogastrica divides Hesselbach's triangle into an internal inguinal fossa (which is the region of the conjoint tendon) and a middle inguinal fossa. Two forms, therefore, of direct inguinal hernia may occur _ dependent upon whether the hernia escapes through the inner two-thirds or the outer one-third of Hesselbach's triangle.

Commoner Form of Direct Inguinal Hernia.—In which the hernia enters the internal inguinal fossa, and either forces its way through the conjoint tendon, in the inner two-thirds of Hesselbach's triangle _ or carries the conjoint tendon before it _ and escapes into the lower part of the inguinal canal. This form of direct inguinal hernia has the following coverings, in order: _ (1) Within Abdomen: _ peritoneum; subserous areolar tissue; general layer of fascia transversalis; _ (2) On its way to lower part of Inguinal Canal: _ conjoint tendon of internal oblique and transversalis (instead of cremaster muscle); and then enters lower part of inguinal canal, which it traverses to emerge at external abdominal ring; _ (3) At External Ring: _ intercolumnar fascia; _ (4) In Scrotum: _ superficial fascia; skin.

Rarer Form of Direct Inguinal Hernia.—In which the hernia enters the middle inguinal fossa, and escapes through the outer third of Hesselbach's triangle _ external to the conjoint tendon _ and enters the upper part of the inguinal canal. This form of direct inguinal hernia has the following coverings in order: _ (1) Within abdomen: _ peritoneum; subserous areolar tissue; general layer of fascia transversalis (instead of infundibuliform process of transversalis fascia, as in the oblique form); _ (2) In Inguinal Canal: _ (which it now enters at its upper part, instead of entering at the internal abdominal ring and travels through the rest of the way); cremaster muscle; _ (3) At External Ring: _ (from which it exits as does oblique hernia); intercolumnar fascia; _ (4) In Scrotum: _ superficial fascia; skin.

Position of Direct Inguinal Herniæ.—Both of the varieties of direct inguinal herniæ lie upon the inner side of the deep epigastric artery. They do not enter the upper opening of the inguinal canal, but pass through the tissues over the os pubis and then enter the canal lower down – but make their exit at the external abdominal ring. Both these direct herniæ generally descend along the inner and anterior aspect of the spermatic cord.

Seat of Stricture in Both Forms of Direct Inguinal Herniæ.—Most frequently at the neck of the sac, – may occur at the external ring. Where the hernia pierces the conjoint tendon, the stricture may be at the margin of the fissure.

Direction of Incision for Relief of Stricture.—Whether in operating for the relief of constriction in oblique inguinal hernia, or in either form of direct inguinal hernia – divide directly upward – which would be external to the deep epigastric artery in oblique inguinal hernia – and internal to it in direct inguinal herniæ.

OPERATION FOR THE RADICAL CURE OF OBLIQUE INGUINAL HERNIA

BASSINI'S METHOD

Description.—Consists in the transplantation of the cord from its old to a new bed – between the internal oblique below, and the external oblique above – formed by suturing the lower borders of the conjoint tendon and the transversalis and internal oblique muscles above, to the shelving portion of Poupart's ligament below – and covering these by suturing the aponeurosis of the external oblique, fascia and skin over them. The hernial sac is ligated and removed at its neck. The constituents of the cord are not disturbed. This was the modern foundation of the radical operation for inguinal hernia.

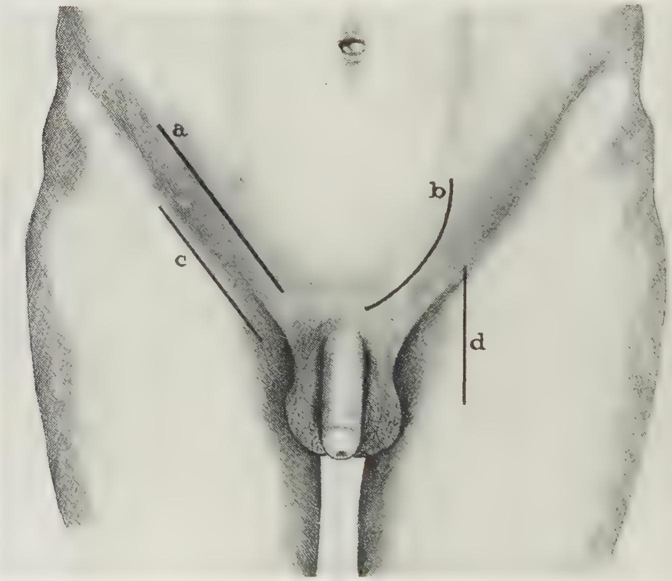


Fig. 3389.—Incisions in Operating for Herniæ: – a, For oblique inguinal hernia; – b, for direct inguinal hernia; – c, oblique incision for femoral hernia; – d, vertical incision for femoral hernia.

Preparation.—Bladder and bowels are emptied and pubic region shaved.

Position.—Patient supine near edge of that side of table upon which hernia is. Surgeon on side of hernia, cutting from above downward on right, and from below upward on left, _ or he may stand upon the right in both cases. Assistant opposite.

Landmarks.—Internal and external rings; inguinal canal; spermatic cord; Poupart's ligament; anterior superior iliac spine.

Anesthesia _ Analgesia.—This is a matter of individual choice. The writer prefers anesthesia in all operations for the radical cure of non-strangulated hernia, unless there be some special reason for employing analgesia.

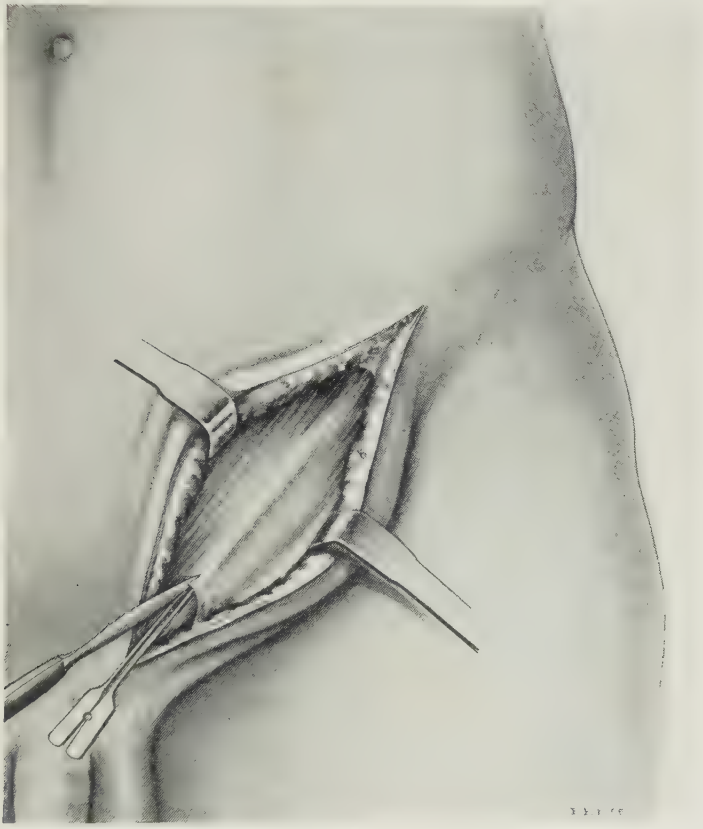


Fig. 3390.—Bassini's Operation for the Radical Cure of Oblique Inguinal Hernia _ I; _ Splitting the aponeurosis and muscular fibers of the external oblique, upon a grooved director, which has been passed through the external abdominal ring, entering the ring between the cord, posteriorly, and the aponeurosis of the external oblique, anteriorly.

Braun's points for local infiltration-analgesia, in operating for oblique inguinal hernia, are shown in Fig. 3369.

Incision.—Begins at a point to the inner side of the anterior superior iliac spine, and about 1.3 cm. ($\frac{1}{2}$ inch) above Poupart's ligament _ passes obliquely downward parallel with and about 1.3 cm. ($\frac{1}{2}$ inch) above Poupart's ligament _ and ends over the middle of the external abdominal ring _ being about 7.5 to 9 cm. (3–3$\frac{1}{2}$ inches) long (Fig. 3389, **a**).

Operation.—Divide skin and superficial fascia, clamping bleeding vessels _ and retract the edges of the wound, exposing the aponeurosis of the external oblique. Demonstrate the external abdominal ring and pass a grooved director through its opening and carry it obliquely upward in the line of the fibers of the external oblique aponeurosis, and immediately beneath its surface, for a distance of about 6.3 cm. (2½ inches) — the instrument showing through its thin texture (Fig. 3390). Slit up the fibers of the aponeurosis of the external oblique upon the grooved director with a scalpel, traveling in the cleavage line of the fibers. Dissect, by blunt separation, the upper edge of the cut aponeurosis inward and upward nearly to the outer edge of the rectus sheath. Similarly dissect, by blunt separation, the lower edge of the cut aponeurosis of the external oblique downward and outward to the shelving portion of Poupart's ligament.

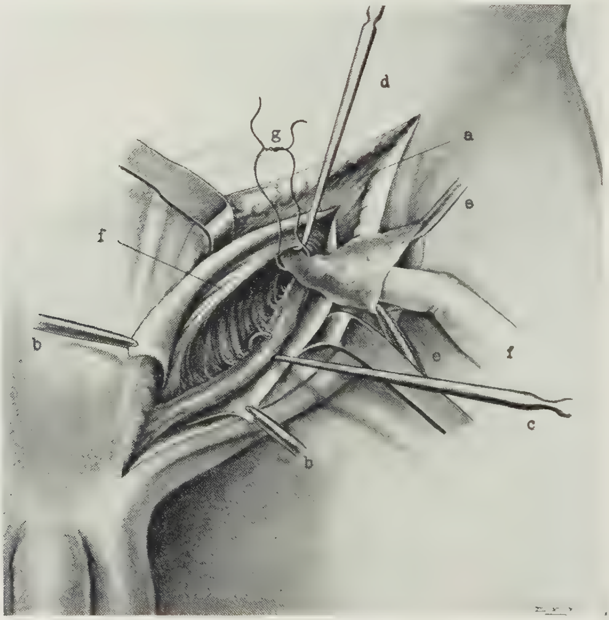


Fig. 3391.—The Same — II; — Isolation of the sac: — **a**, External oblique — whose split margins are drawn back by clamps at **b** and **b**; — **c**, hook, holding the cord to one side; — **d**, hook-retractor drawing upward and outward the lower border of the internal oblique, to aid in exposing the neck of the hernial sac; — **e**, **e**, the clamped margins of the incised peritoneal sac — the interior of which a finger, **f**, is examining, to see if a loop of intestine, adherent, or otherwise, be present; — **g**, ligature, about to be tied high up upon the neck of the sac.

The inguinal canal, except that part covered by the internal oblique, is thus exposed.

Grasp, with forceps, aided by the fingers, the mass of soft tissues just within, or emerging from the external abdominal ring, composed of cord and hernial sac — and, pushing aside the muscle-fibers with a blunt dissector, or closed ends of blunt, curved scissors, lift upward and outward the hernial sac and cord — drawing them partly from the direction of the inguinal canal, and partly from the direction of the scrotum — the hernia lying anteriorly, surrounded by the infundibuliform fascia, and the cord posteriorly — the sac and cord being more or less intimately adherent.

Isolate the sac from the cord by blunt dissection — and carry on the freeing of the sac upward, retracting the internal oblique muscle outward to expose the outer aspect of the inguinal canal, until the sac begins to open out into the general peritoneum. If it be certain that the sac contains no adherent intestines or omentum, it need not be opened. If there be question _ and it is distinctly better in all cases to do so, whether question or not _ the sac should be opened at some distance below the point of intended closure and examined. The contents of the sac, if any, are returned to the abdominal cavity. The sac is then to be treated in one of two ways: _ If it be small, a double chromic gut ligature is carried through the center of that portion which is to form the line of occlusion _ these two ligatures are crossed and are firmly tied on each side _ and the sac cut off a safe distance from the ligatures (Fig. 3391). If the sac be large (so that ligating would cause too much puckering and probably slip off), its surfaces are to be sutured with chromic gut on a level with the site of division _ and then cut off with scissors at a safe distance distal to the suture line. The sac is thus disposed of and returned to the abdominal cavity.

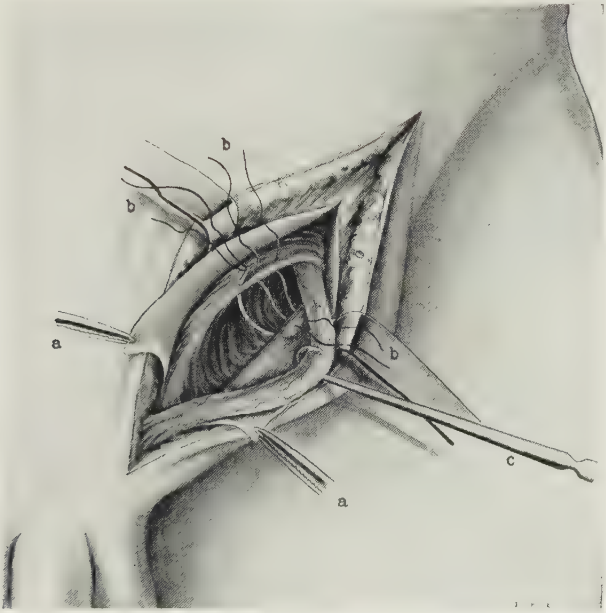


Fig. 3392.—The Same _ III; _ Forming the new floor for the cord: _ **a, a,** Retracted margins of the split external oblique; _ **c,** hook-tractor, displacing the cord _ which, at the same time, is made to strongly retract outward the internal oblique and transversalis; _ **b, b,** sutures, approximating the internal oblique, above, to the shelving portion of Poupart's ligament, below, beneath the cord _ thus constituting its new bed.

The cord is now taken up in the left thumb and index and isolated from external ring, *en masse*, without disturbing its component structures, and a strip of gauze is passed beneath it _ whereby it is held up by an assistant well out of the way, until its new bed is made for it. The lower borders of the internal oblique and transversalis muscles are now sutured to the shelving portion, or border of Poupart's ligament, with interrupted sutures of kangaroo-tendon or chromic gut, taking a good hold of both structures, using a curved needle. Prior to the insertion of the sutures uniting the internal oblique and transversalis above, to Poupart's ligament below, the lower borders of the internal oblique and transversalis should be isolated by the Surgeon's fingers from the transversalis fascia, beginning at the conjoint tendon and extending outward to the internal abdominal ring. While passing the sutures, the Surgeon's left index should be carried behind the conjoint tendon and also behind the lower borders of the internal oblique and transversalis muscles, so as to guide the needle-point. The first suture, near the upper end of the wound, pierces the internal oblique almost as far outward as the external border of the rectus muscle. It should just come in contact with the inner aspect of the cord when the latter is held at a right angle to the plane of the internal oblique muscle as it emerges from opposite the internal ring. A second suture is placed just above the cord, to strengthen the internal ring, the cord thus emerging between two sutures. As many similar sutures as are indicated (generally six or seven altogether) are thus placed. The last, lowest, suture passes through the conjoint tendon of the internal oblique and transversalis above, and the shelving portion of Poupart's ligament below (Fig. 3392).

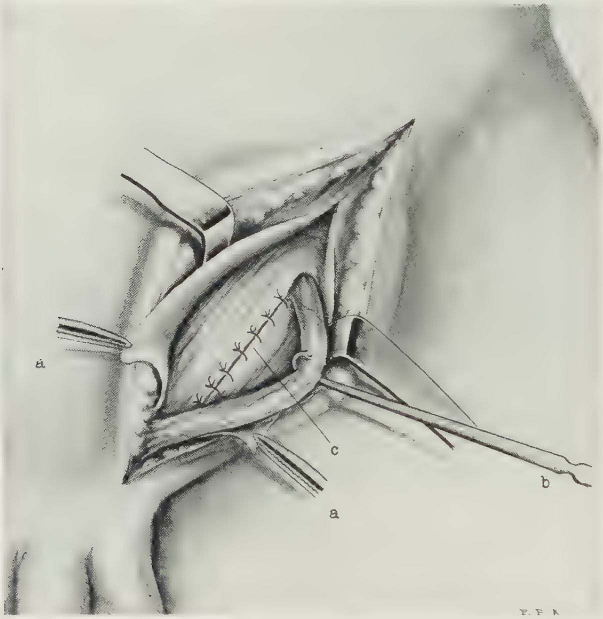


Fig. 3393.—The Same – IV: – **a, a,** The retracted margins of the split external aponeurosis; – **b,** displaced cord; – **c,** new bed for the cord – formed by the suturing of the lower margin of the internal oblique and transversalis, to the shelving portion of Poupart's ligament. The roof of the new inguinal canal will be formed when the free margins of the split external oblique are sutured together.

The cord is now dropped down upon its new bed made by suturing the conjoint tendon and the internal oblique and transversalis muscle to the shelving border of Poupart's ligament (Fig. 3393).

The separated edges of the aponeurosis of the external oblique are now sutured directly over the cord with continuous kangaroo or chromic gut sutures – carefully avoiding too tightly suturing the edges over the cord at the lower end, the new external ring, where the cord escapes into the scrotum (Fig. 3394). The skin is closed throughout with interrupted sutures of fine catgut. No drainage is used. The first dressing usually comes off at the end of a week.

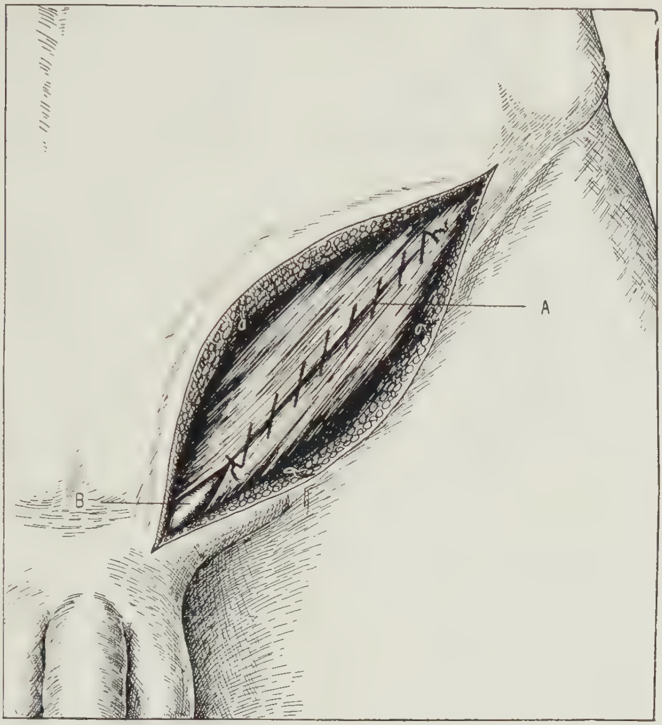


Fig. 3394.—The Same _ V; _ Formation of the new roof of the inguinal canal: _ A, the sutured together margins of the split external oblique in its muscular and aponeurotic portions; _ B, the cord, making its exit from the new inguinal canal _ the floor of which is formed by the suturing of the lower borders of the internal oblique and transversalis, to the shelving portion of Poupart's ligament _ and its roof, by suturing together the split portions of the external oblique.

Comment.—No muscle tissue, except aponeurosis of external oblique, is cut, and that is separated in its cleavage line.

OPERATION FOR THE RADICAL CURE OF OBLIQUE INGUINAL HERNIA

HALSTED'S METHOD

Description.—Like Bassini's operation, which it resembles in many respects, Halsted's original method consisted not only in a transplantation of the cord from its natural to a new canal but also in the making of a new, closely fitting internal ring. It differed from Bassini's technic in the following respects: _ (*a*) a new internal ring was made; _ (*b*) most of the veins of the cord were excised; _ (*c*) the internal oblique and transversalis muscles and transversalis fascia were incised; _ (*d*) the cord was finally made to lie between the aponeurosis of the external oblique and the skin; _ and (*e*) silver wire mattress-sutures were extensively used. The original technic has been considerably modified _ as described under Operation.

Preparation _ Position _ Landmarks.—As for the Bassini operation.

Incision.—Begins about 3 cm. ($1\frac{1}{4}$ inches) to the outer side and above the internal abdominal ring _ and extends thence in a straight line to the spine of the pubis (Fig. 3389, **a**).

Operation.—Incise skin and fascia and split the fibers of the muscular and aponeurotic portions of the external oblique along this line, to and through the external ring. Retract the borders of the incision, thus exposing the cord, cremaster muscle and fascia, vessels, and hernial sac. The fibers of the cremaster muscle (which constitutes the lower part of the internal oblique muscle) are split somewhat above the cord. The vessels, especially the redundant veins, are isolated, grasped with forceps at either end, and ligated and divided at the internal and external rings — and are carefully dissected away between the sites of ligation, retracting and guarding the vas deferens (Fig. 3395). Having freed the hernial sac, incise it and return its contents to the abdominal cavity.

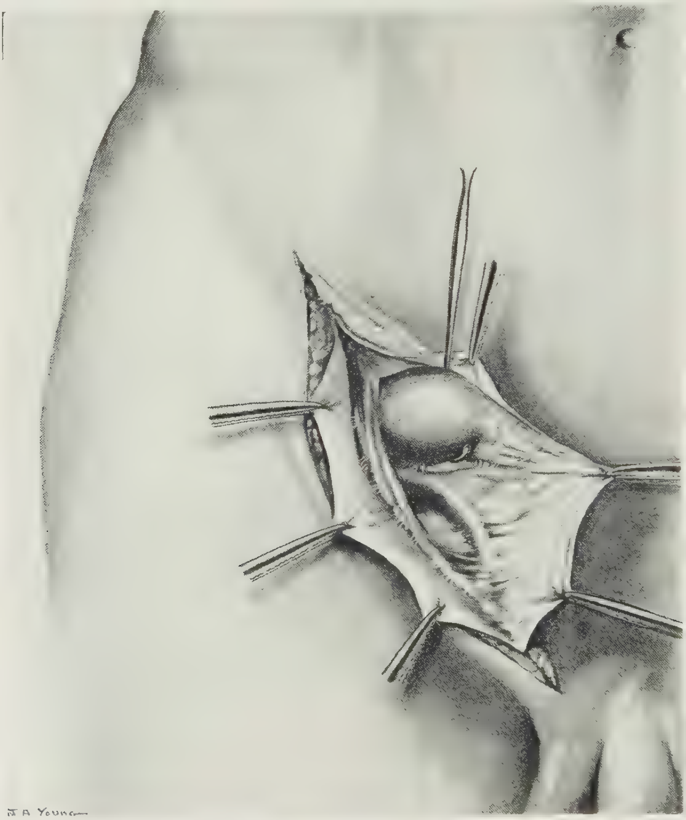


Fig. 3395.—Halsted's Operation for the Radical Cure of Oblique Inguinal Hernia — I; — The aponeurosis and fibers of the external oblique have been split and retracted The fibers of the cremaster (inner, lower part of the internal oblique) have been split and retracted upward, somewhat above the cord. The hernial sac, spermatic cord (seen convexly curving downward, to enter the scrotum), and veins are seen in the mass of connective tissue, being retracted upward and inward by catch-forceps. Similar forceps are holding apart the margins of the split external oblique. (Figs. 3395–3399 are modified from Broedel's illustrations of the Halsted operation.)

Having especially freed the neck of the sac, transfix and ligate it with chromic gut, leaving both ends of the ligature long. Each end of this ligature is threaded with a curved needle — both of which are carried upward and inward under the internal oblique, 1.3 cm. ($\frac{1}{2}$ inch) apart, and passed through the muscle and tied so as to draw the neck of the sac up and anchor it.

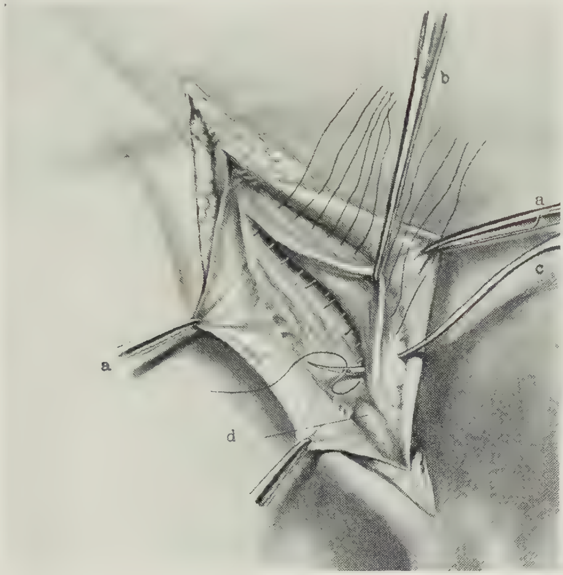


Fig. 3396.—The Same _ II; _ The cremasteric, or lower portion of the internal oblique, in the act of being sutured by interrupted mattress-stitches _ to the upper and inner portion of the internal oblique: **a, a,** Tractors of the margins of the split external oblique; _ **c,** Reverdin needle, carrying the free ends of the loops of the already placed mattress-sutures, through the internal oblique, at some distance from its free edge; _ **d,** the cord.

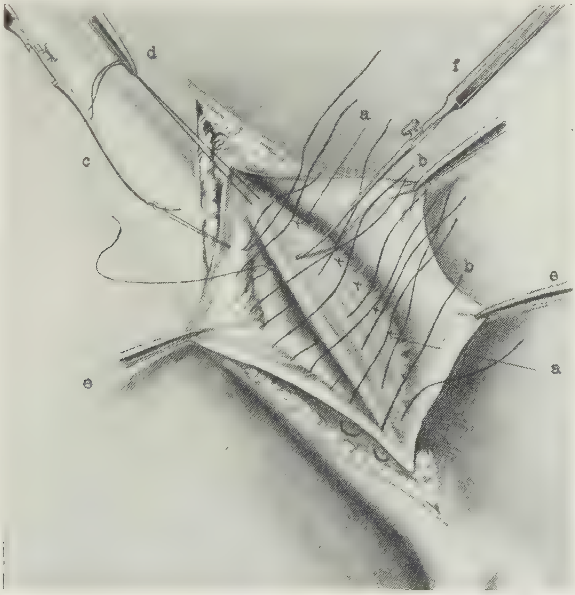


Fig. 3397.—The Same _ III; _ **e, e,** Tractors of the margins of the split external oblique; _ **d,** ends of the ligature of the stump of the hernial sac, brought out through the overlying abdominal muscles, opposite the internal ring, where their ends will be tied, as an anchorage of the stump at the upper end of the inguinal canal; _ **a, a,** the knots of the first tier of sutures, shown in the preceding picture; _ **b, b,** interrupted sutures, uniting the lower border of the internal oblique, to the shelving border of Poupart's ligament; _ **c,** Reverdin needle, placing one of the suture-loops in the shelving border of Poupart's ligament; _ **f,** Reverdin needle, drawing one of the limbs of these loops through the internal oblique, near its free border.

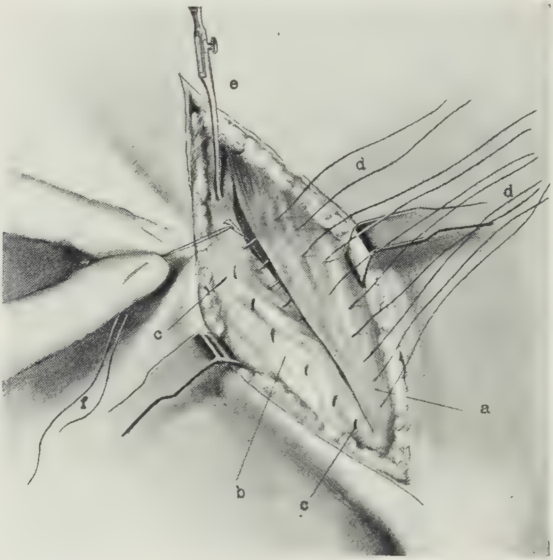


Fig. 3398.—The Same – IV: – **b, c, c,** Outer aspect of the loops of the interrupted sutures, **b, b,** shown in the preceding illustration; – **e,** Reverdin needle, placing interrupted mattress-sutures, **c, c,** near the margin of the lower portion of the split external oblique, **b,** in the act of making the loop by drawing the suture, **f,** through; – **a,** upper portion of the split external oblique; – **d, d,** free ends of the limbs of the mattress-sutures, **c, c,** drawn through the upper portion of the split external oblique, so that, when tied, they will cause the upper to overlap the lower portion of the split external oblique.

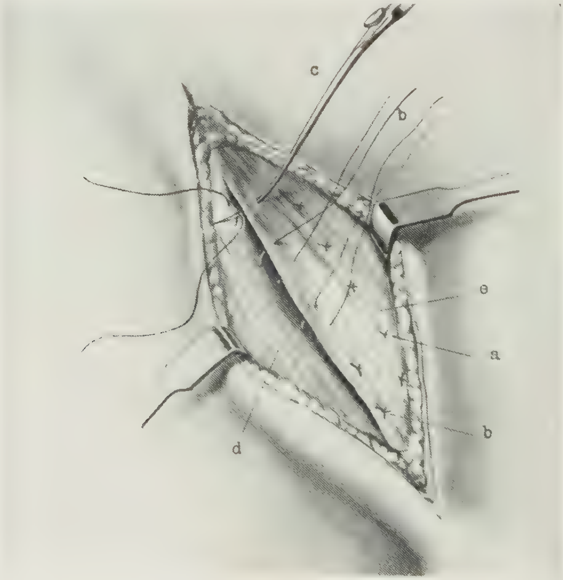


Fig. 3399.—The Same – V; – Completion of the operation, by the suture of the free margin of the upper split part of the external oblique, to Poupart's ligament: – **d,** Poupart's ligament; – **e,** overlapping upper portion of the split external oblique; – **a,** line of knotted sutures shown placed, ready to be tied, in the preceding illustration; – **b, b,** interrupted mattress-sutures, uniting the free margin of the upper portion of the split external oblique, to the surface of the lower portion of the external oblique; – **c,** Reverdin needle, carrying the limbs of the mattress-loops of the overlapped part of the external oblique, through the overlapping portion of the external oblique, near to but not including its margin.

Mobilize the median aspect of the split internal oblique sufficiently to subsequently enable its edge to reach to Poupart's ligament _ and suture it to the outer aspect of the split internal oblique by several mattress-sutures of fine silk (or chromic gut) _ in such a way as to cause an overlapping of the median upon the outer aspect of the internal oblique (Fig. 3396). Suture the free edge of the internal oblique, the conjoint tendon (and a part of the sheath of the rectus, if necessary) to the shelving portion of Poupart's ligament by interrupted chromic gut sutures (Fig. 3397). Suture, with chromic gut mattress sutures, the inner aspect of the aponeurosis of the external oblique

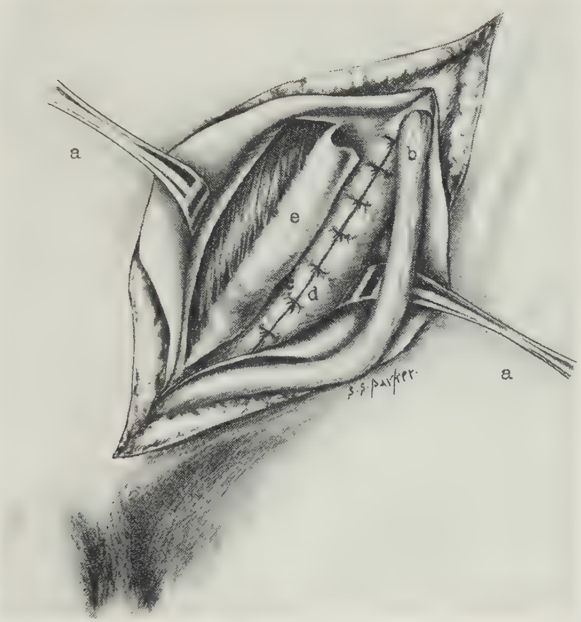


Fig. 3400.—Berger's Method of Reinforcing the Region of Inguinal Hernia by Means of a Turned-down Flap of Aponeurosis Derived from the Rectus _ I; _ Having isolated the cord _ isolated, opened, ligated, and excised the hernial sac _ sutured the internal oblique and transversalis to the lower aspect of the shelving border of the Poupart ligament, **c, d,** to form a new bed for the cord _ the aponeurotic flap, **e,** is raised from the rectus, ready to be turned over the cord, **b.** **a, a,** Retracted margins of the aponeurosis of the external oblique. The incision of the anterior layer of the rectal sheath is either for the purpose of affording relaxation to the internal oblique, thereby enabling it to reach Poupart's ligament, or for the reinforcement of the inguinal canal. It is here being sutured to Poupart's ligament for the latter purpose. When the two margins of the aponeurosis of the external oblique are sutured together, the weakened area of the rectus will be covered.

to the outer aspect of the external oblique aponeurosis _ causing the former to overlap the latter (Fig. 3398). And then suture, with plain, interrupted chromic gut stitches, the free border of the inner aspect of the external oblique aponeurosis down to the outer surface of the outer aspect of the external oblique (Fig. 3399). The skin wound is closed with a subcuticular silver-wire suture. The suture line is covered with silver foil _ which is removed in two weeks, at which time the subcuticular suture of wire is withdrawn.

Comment.—This operation is, essentially, one of the many modifications of the Bassini technic.

In making the partial excision of the veins, all but two or three are excised.

A portion of the sheath of the rectus muscle, contributing, as it does, to the aponeurosis of the internal oblique, may be utilized, if necessary, for the purpose of reinforcement _ either to better enable the free border of the divided internal oblique to reach down to Poupart's ligament _ or for closing the lower part of the inguinal canal _ as shown in Figs. 3400 and 3401.

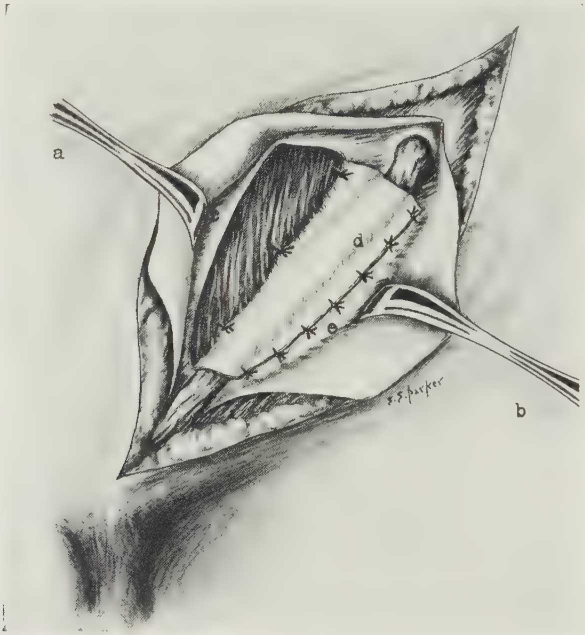


Fig. 3401.—The Same _ II: _ The turned-down flap of rectal aponeurosis, **d**, has been sutured to the shelving border of Poupart's ligament, **e**, along a somewhat higher level than were the borders of the internal oblique and transversalis. The "hinge" of this aponeurotic flap has been reinforced by a few sutures. The margins of the split external oblique, **a** and **b**, will be sutured over the displaced aponeurotic flap.

OPERATION FOR THE RADICAL CURE OF OBLIQUE INGUINAL HERNIA

KOCHER'S OPERATION

Description.—No free incision of aponeuroses or muscles is made. The aponeurotic covering of the inguinal canal is exposed, from below the external ring, to above the site of the internal ring _ a small incision being made through the aponeurosis opposite the inner ring. The hernial sac is then isolated _ and either pushed outward along the inguinal canal by invagination _ or drawn out by lateral displacement, without invagination. In both cases, it is ligated at the internal ring, and cut off. The aponeurotic incision and the inguinal canal are closed by suture.

Preparation _ Position.—As in Bassini's operation.

Anesthesia _ Analgesia.—Either may be employed, as the Surgeon elects.

Landmarks.—Poupart's ligament, and the external and internal inguinal rings.

Incision.—The incision begins about 1.2 cm. ($\frac{1}{2}$ inch) above the middle of Poupart's ligament _ and passes downward and inward, parallel with

Poupart's ligament, to end 2.5 cm. (1 inch) internal to the external abdominal ring (Fig. 3402).

Operation.—Incise skin and superficial fascia _ dividing the superficial epigastric artery and a small vein to the inner aspect of the wound _ both of which are to be tied. Demonstrate the pillars of the external abdominal ring by blunt dissection _ and incise the external spermatic, or Cooper's fascia (a thin prolongation of the external oblique to the cord) _ exposing beneath it, the cremasteric and infundibuliform (transversalis) fascia. Incise the cremasteric and infundibuliform fasciæ _ guarding the spermatic vessels and nerves. When the incision has passed through the infundibuliform fascia, free the hernial sac from the cord structures (which is expedited by holding the cord up to the light) _ freeing from the external ring downward _ seizing the fundus and drawing it downward, so as to expose the highest part of the sac _ from which the cord is then stripped, by means of gauze dissection.

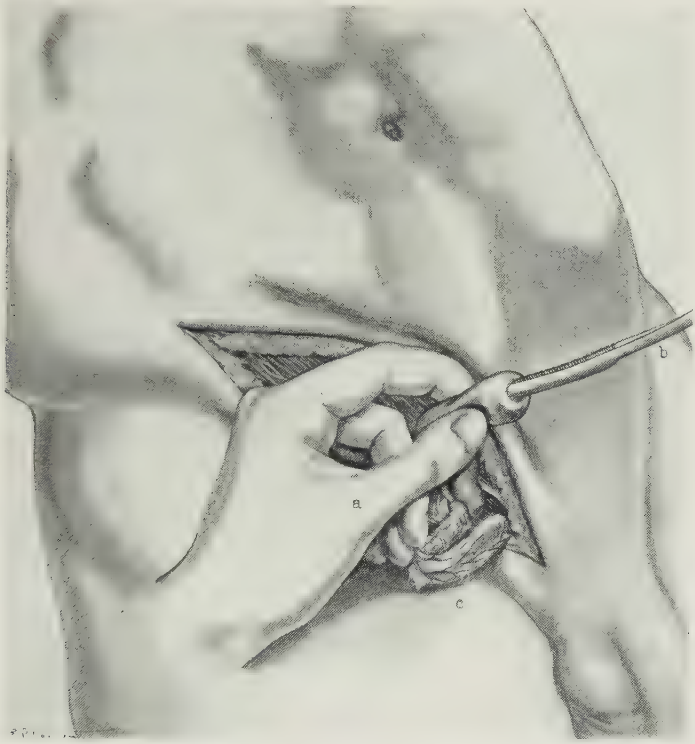


Fig. 3402.—Kocher's Operation for the Radical Cure of Oblique Inguinal Hernia by the Invagination Transposition Method _ I; _ Having isolated the hernial sac, it is invaginated upon itself, from the fundus _ and thence outward, to the upper end of the inguinal canal, opposite the internal ring: _ **a,** Fingers, steadying the fundus of the sac, while forceps, **b,** accomplish the invagination; _ **c,** the cord, partially displaced.

The following stage of the procedure will depend upon whether the sac can be readily invaginated into itself from below (which is usually the case, in uncomplicated adult hernia) _ in which case the sac is treated by transposition and invagination. If this cannot be done (as is often the case in children), the sac is treated by simple lateral transposition. In either case, the contents of the sac are first reduced.

(I) **Transposition by Invagination.**—This is the method of choice _ and the most effective. Seize the fundus of the sac with Kocher's long, curved artery-forceps _ and invaginate it backward and upward (Fig. 3403) _ following the inguinal canal, and causing the forceps to hug the anterior wall of the canal all the way along, until the internal abdominal ring is reached _ when the forceps are made to press forward. Keep in touch with the anterior wall of the canal throughout _ and do not pass too high upward. Make a small incision over the end of the protruded forceps, in the cleavage line of the fibers of the external oblique aponeurosis _ and push the end of the forceps through _ their ends being covered by parietal peritoneum _ which is incised and grasped by forceps _ after which, the tip of the protruded hernial sac is seized with clamp-forceps _ and the curved dressing-forceps, with which it was carried through the canal, relaxed and withdrawn. The entire length of inverted hernial sac, with its serous surface outward, is then drawn upward and outward, strongly. After incising the fundus and examining the cavity of the sac, its neck is transfixed, and is securely ligated at the aponeurotic opening and divided _ the ligated stump slipping back (Fig. 3404). The small openings in the parietal peritoneum and in the aponeurosis are sutured _ and the in-

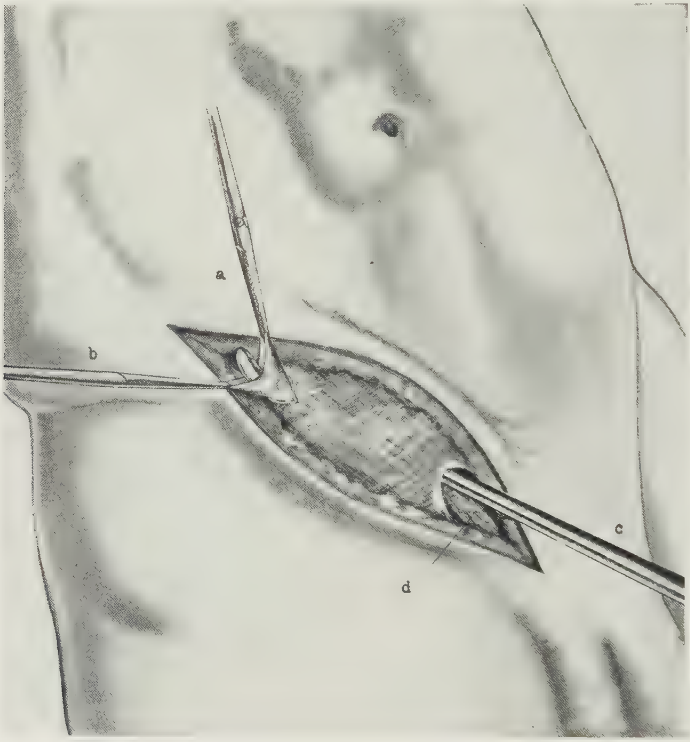


Fig. 3403.—The Same _ II; _ The inner half of Poupart's ligament, and the aponeurosis immediately above, have been exposed. An incision has been made through the aponeurosis of the external oblique and the deep abdominal muscles, opposite the internal ring, through which the hernial sac is to be drawn out _ the presence and position of which are shown by the bulge. **c**, Forceps, along the inguinal canal, protruding outward the hernial sac, whose fundus was invaginated in the preceding illustration, outside of the external ring _ and determining the position of the incision by its prominent tip; _ **a**, **b**, clamps, grasping the lateral aspects of the hernial sac, protruded through the incised external oblique _ where the sac is incised upon the separated points of the conducting forceps; _ **d**, the cord.

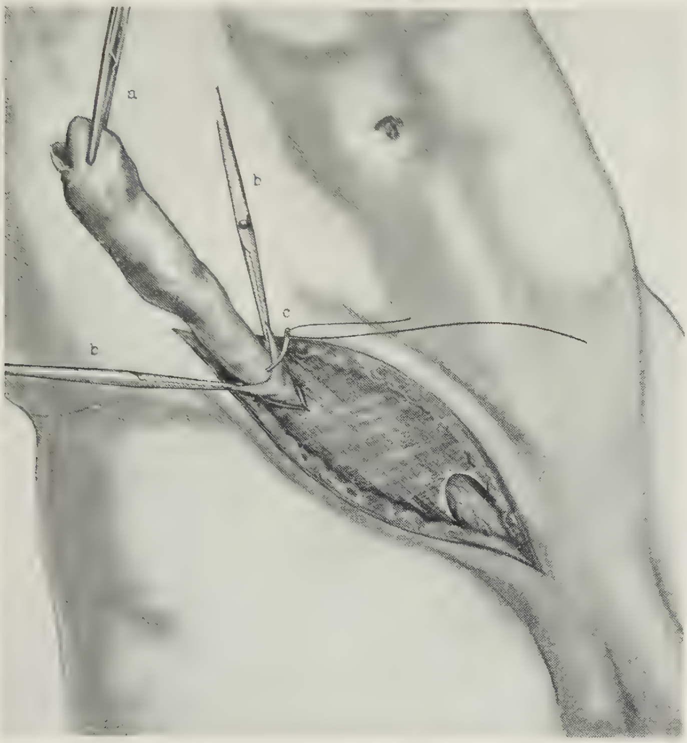


Fig. 3404.—The Same _ III; _ After having incised the fundus of the sac and demonstrated the absence of intestinal coils, its neck is ligated, and the redundant sac excised just beyond the ligature: _ **a,** The incised peritoneal sac, under gentle tension; _ **b, b,** margins of incised fascia, clamped and separated from the neck of the sac _ so as to free the neck of the peritoneal sac from all extraneous tissue; _ **c,** needle in the act of transfixing the neck of the drawn-out hernial sac, carrying a ligature which will be crossed and tied. Every care must be exercised, before tying, that no intestinal wall be caught in the ligature.

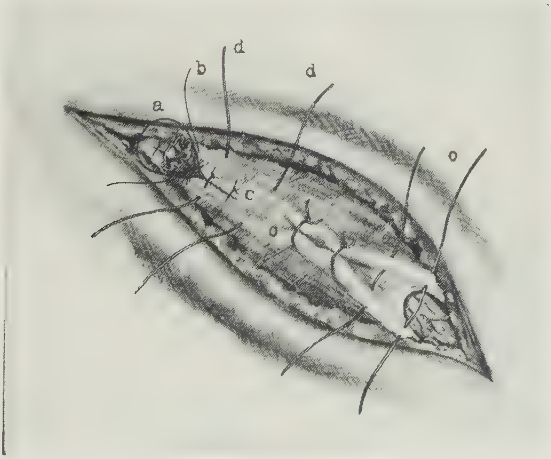


Fig. 3405.—The Same _ IV; _ The inguinal canal and external ring are being obliterated by transversely placed sutures _ while the anterior wall of the canal is depressed during the tying of the stitches: _ **a,** The ligated neck of the sac about to be dropped back into the abdomen; _ **b, c,** sutures of the split external oblique; _ **d, d,** folding in the anterior wall of the inguinal canal by means of simple sutures, **o, o,** or accomplishing the same by means of Lembert sutures, as distinctive of the Kocher technic.

guinal canal is closed in the following manner: _ several sutures are carried beneath the aponeurosis of the external oblique, along the site where it forms the anterior boundary of the inguinal canal, the sutures crossing the aponeurotic fibers at a right angle. While the finger depresses this tract the sutures are tied _ thus forming two parallel and approximated folds (Fig. 3405). From two to four sutures are inserted, to approximate the pillars of the ring _ but so applied as not to cut off the circulation in the cord.

(II) **Lateral Transposition.**—This method is adopted when the sac cannot be invaginated _ because either of its thinness, tension, shortness, or the general indication to remove it. Seize the apex of the hernial sac with the same kind of forceps as in the last method and carry it up the inguinal canal _ closely hugging the anterior wall of the canal _ up to the internal abdominal ring _ and there push it through a small incision made in the aponeurosis, and draw it forcibly out (Fig. 3406). In this case, the parietal peritoneum is not opened as the sac has not been invaginated. The neck of the hernial sac is strongly ligated close to the aponeurotic slit, and divided _ the stump being allowed to slip back into the abdomen. The aponeurotic opening is sutured _ and the inguinal canal is closed as in Method I, just described.

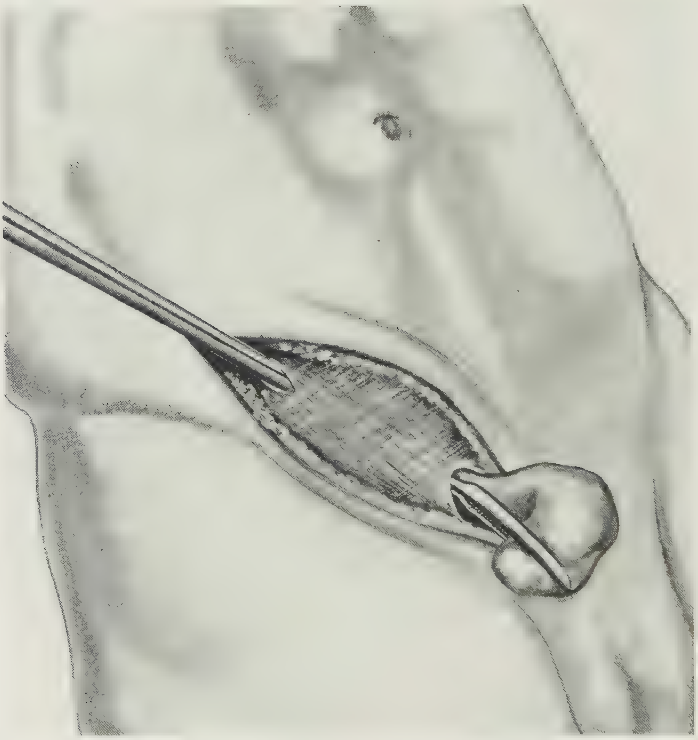


Fig. 3406.—Kocher's Operation for the Radical Cure of Oblique Inguinal Hernia by the Lateral Transposition Method; _ A pair of long, slightly curved, dressing forceps, with catch, has been carried down the inguinal canal, from an incision through the external oblique, over the internal ring _ after which the fundus of the sac has been seized and is being drawn outward _ where it will emerge through the outer opening, as in the transposition-invagination method _ except that, here, no invagination occurs.

Comment.—Kocher lays special stress upon the use of silk, as a suture material _ and upon the avoidance of bleeding into the wound.

It is especially when the veins are large and numerous that excision is indicated _ but, in any event, two or three should be left. They are doubly ligated, and divided _ as high up as possible, but external to the external abdominal ring.

It is best not to handle, or in any way disturb, the vas deferens from its bed, in order to avoid thrombosis of its veins.

It is, of course, much easier to place the two ends of the ligature, after tying the neck of the sac, by means of a Reverdin-needle.

It will be seen that the lower flap of cremaster is displaced upward, by mattress-sutures, under the inferior surface of the freed internal oblique _ and that the free border of the mobilized internal oblique, together with the conjoined tendon, is sutured to Poupart's ligament _ and that if greater play of the internal oblique is needed, in order to reach Poupart's ligament, or more covering is wanted for the inguinal canal, these ends may be secured by incising the anterior sheath of the rectus muscle and turning down the portion of aponeurosis thus freed for utilization in any way indicated.

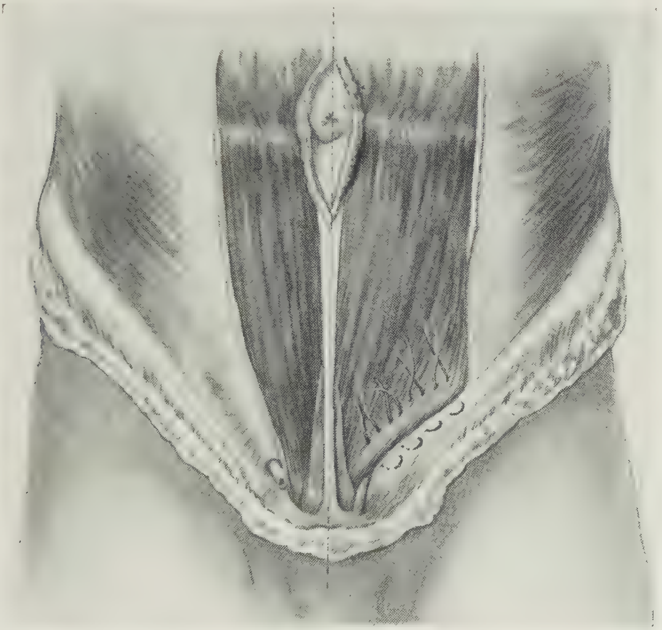


Fig. 3407.—Bloodgood Method of Utilizing the Transplanted Border of the Rectus Muscle _ by suturing it to Poupart's ligament, in order to reinforce the region of the conjoint tendon.

Many minor variations of technic have been applied in performing the operation.

Patients usually remain in bed from eighteen to twenty-one days.

It sometimes happens that there is weakness, or deficiency in the region of the conjoined tendon _ and, in such cases, Bloodgood has suggested incising the sheath of the rectus muscle, and bringing the latero-inferior aspect of the rectus down to Poupart's ligament, and suturing it there (Fig. 3407).

OPERATION FOR THE RADICAL CURE OF BILATERAL OBLIQUE INGUINAL HERNIÆ BY A SINGLE TRANSVERSE INCISION

JUDD'S TECHNIC

Description.—The single transverse incision may be used in operating upon double oblique inguinal hernia, instead of two oblique incisions — which represents some gain in the element of time — and the wound is somewhat removed from the scrotal region, whence infection so readily occurs.

Operation.—A transverse incision is made from a midpoint between the internal and external abdominal rings of one side, to a corresponding point on the other (Fig. 3408) — and is usually from 3 to 12 cm. ($1\frac{1}{3}$–$4\frac{3}{4}$ inches) in length. Carry the incision through skin and fascia, down to the aponeurosis of the external oblique. The regions of both external abdominal rings is cleared of fatty connective tissue, by sharp and blunt dissection — the use of gauze upon the finger-tip being of aid — and, in the same manner, both inguinal canals are exposed and cleared. Instead of incising the aponeurosis of the external oblique in the usual way, it is incised about 1.2 cm. ($\frac{1}{2}$ inch) to the inner side of the cord, and connected with the ring by a short angular cut, thus forming a small flap, at its lower end (Fig. 3409). The lips of the incised aponeurosis are separated — and the cord and hernial sac exposed (as shown in the same picture).

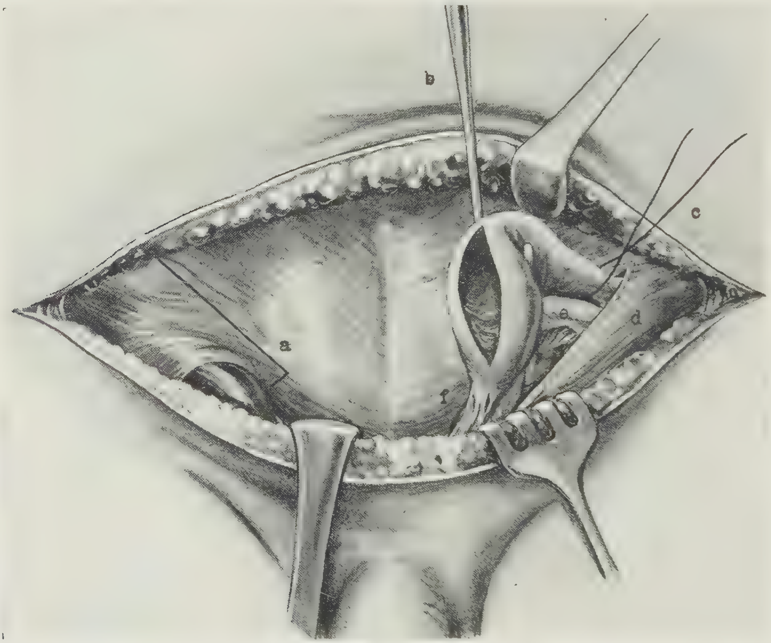


Fig. 3408.—Operation for the Radical Cure of Bilateral Oblique Inguinal Hernia by a Single Transverse Incision — Judd's Technic — I; — The transverse incision passes between the midpoints, between the external and internal inguinal rings of the two sides. The skin and fascial flaps have been retracted. On the patient's right, the cord is being exposed by an incision which also forms a small aponeurotic flap, **a**. On his left, the margins of the aponeurotic flap have been retracted — and the cord, **e**, is being freed from the hernial sac, **b** — which is also shown incised. The neck of the sac, **c**, is being ligated. Connective tissue and vessels of the cord are seen at **f**. (Figs. 3408 and 3409 modified from Judd.)

The hernial sac is exposed and dealt with as usual — first upon one side, and then upon the other. The free margin of the external oblique aponeurosis is mobilized, and sutured, along with the conjoint tendon and internal oblique, to Poupart's ligament (Fig. 3409) _ after which, the cord is dropped down upon it. The free edge of the small aponeurotic flap (of external oblique fascia) originally made, is now drawn over the cord and sutured to the surface of the external oblique aponeurosis (as seen in the picture last quoted). Finally, the superficial tissues are lightly sutured with catgut _ and the skin with subcutaneous catgut _ or by through-and-through horsehair stitches.

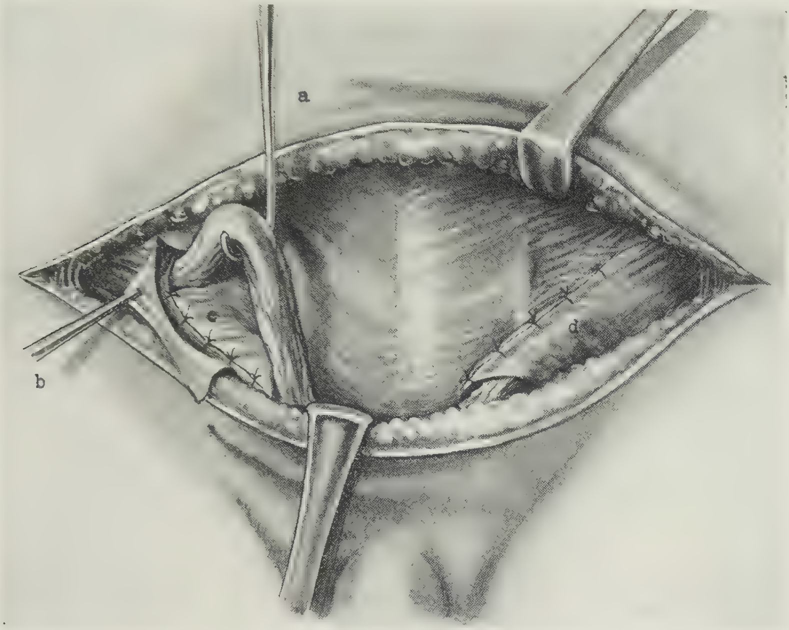


Fig. 3409.—The Same _ II: _ **a**, The displaced cord; _ the upper margin of the split external oblique is brought under the up-raised cord, and sutured, at **e**, to the internal oblique, conjoint tendon, and Poupart's ligament. The lower margin of the split external aponeurosis, represented by the previously explained flap, **b**, is now brought over the cord, which has been dropped upon its new floor, and sutured to the surface of the aponeurosis of the external oblique at **d** _ so that the spermatic cord comes to lie between two layers of the external oblique aponeurosis.

OPERATION FOR THE RADICAL CURE OF OBLIQUE INGUINAL HERNIA IN THE FEMALE

The operative procedure is, here, practically the same as that for the radical cure of oblique inguinal hernia in the male. The hernia ordinarily follows the route of the round ligament _ passing down through the unobliterated process of the peritoneum which partly covers the round ligament and is known as the canal of Nuck. But the round ligament lies actually outside of the peritoneum, although very intimately connected with it _ so that it is very difficult, or impossible, to free and ligate the hernial sac in a female. To make such a dissection, as is often necessary in freeing the sac, is apt to be tedious and to damage the vascular supply of the parts.

Rather than to cut through the round ligament (one of the two alternatives) it is better to carry a ligature through the round liagment, just under the peritoneum, and then around the non-peritoneal portion, thus including them both in the one ligature _ whereby the canal is obliterated.

The internal and external inguinal rings may be closed as in Bassini's operation upon the male.

It is not necessary to treat the round ligament as the male spermatic cord is treated. It can remain within the inner angles of internal and external abdominal rings.

OPERATION FOR STRANGULATED INGUINAL HERNIA

Description.—The operation is begun, primarily, to relieve the constriction which, by strangulation, is endangering the integrity of the bowel. After the delivery of the bowel, if examination proves it to be safely viable, it is returned to the abdominal cavity. If not, the necessary portion is generally excised, and the sound ends united by one of the methods of entero-enterostomy _ or, if emergency demands it, the opened bowel may have to be temporarily anchored in the wound. In all cases where it is possible to do so, the operation is terminated by one of the methods of radical closure of the hernial site.

Incision.—The skin incision usually begins about 2.5 cm. (1 inch) above and to the outer side of the internal abdominal ring _ and extends downward and inward, passing over the neck of the hernial sac _ to end at the root of the scrotum.

Operation.—The incision is carried down to the sac _ which is carefully freed by combined sharp and blunt dissection _ exercising care not to damage the spermatic cord, which is nearly always found posterior to the neck of the hernial sac. The sac should be isolated and invariably opened _ for the purpose of determining the condition of the intestine, and to thereby avoid any chance of returning a piece of non-viable intestine to the abdominal cavity (Fig. 3410).

The constriction is now divided _ and this is usually found at either the external or internal abdominal ring. The division of the constricting ring is made outside of the hernial sac _ and was formerly generally accomplished by carefully introducing a special curved, probe-pointed herniotomy bistoury between the hernial sac and upper aspect of the ring _ and then cutting directly upward (which would be external to the deep epigastric artery, in oblique inguinal hernia _ and internal to it, in direct inguinal hernia). It is preferable, as well as more surgical, however, to incise the constriction from without inward _ proceding carefully, either with a knife, or by snips with probe-pointed scissors. In this safer method of approaching from without the epigastric is exposed to view, and thereby safeguarded. The ring is cut only sufficiently to release the imprisoned intestine. A blunt hook-retractor introduced after a limited incision will aid in the release of the parts. During these steps, the intestinal coil is kept from slipping back into the peritoneal cavity _ being surrounded by moist gauze and drawn outward somewhat.

The examination of the delivered coil of intestine should be very thorough, as the passage of judgment upon its integrity is a matter of importance. If the intestine be safely viable, its contents are gently pressed back into the abdominal cavity _ until finally the intestine itself escapes within the peritoneum. If the intestine be non-viable, the non-viable portion is drawn down and excised, and some form of entero-enterostomy performed. If the integrity of the intestine be in doubt, individual judgment alone can guide the Surgeon. In doubtful cases the coil of intestine can be wrapped in a warm saline towel and left in the wound, outside of the peritoneal cavity for twelve or more hours. At the end of this time, if it have recovered, it may be returned to the abdominal cavity _ otherwise it is resected. If there be grave doubt, act on the safe side and excise.

Having dealt with the intestine as indicated, the hernial sac is drawn down and out somewhat, transfixed at its neck, tied and cut off below the ligature _ while the part of the peritoneal sac which may be adherent within the scrotum, is either dissected out _ or, if healthy, left *in situ*.

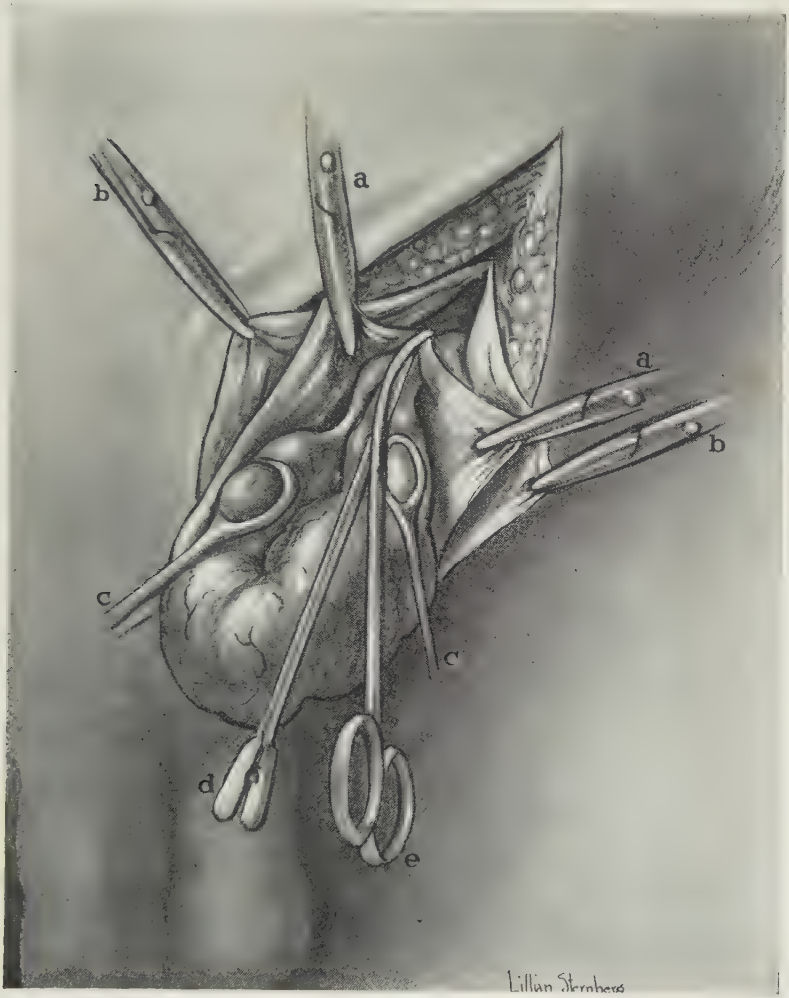


Fig. 3410.—Operation for Strangulated Oblique Inguinal Hernia: _ **b, b,** The incised and retracted aponeurosis of the external oblique _ the internal oblique is seen displaced upward and outward, between the upper margin of the incised external oblique and the incised hernial sac; _ **c, c,** tractors of the limbs of the loop of intestine _ the constricted portion, or "neck," being seen just above these; _ **d,** grooved director, passing between the constricted neck of the intestinal limbs and the incised hernial, or peritoneal sac; _ **e,** scissors, one blade of which is engaged in the groove of the director, in the act of further dividing the constricted neck of the hernial sac. The cord is hidden by the sac of the hernia.

If the patient's condition admits of further prolonging the operation, the hernial site is dealt with by one of the methods of radical cure, such as have just been described. Where such a procedure is contraindicated by the patient's general or local condition, the wound is closed _ and the radical operation performed, if necessary, later. Drainage is not used unless specially indicated.

OPERATION FOR THE RADICAL CURE OF DIRECT INGUINAL HERNIA

DOWNES' TECHNIC

Description.—The hernial sac is removed as completely as possible — and, in those cases in which the epigastric vessels divide the hernial sac into two compartments, or portions — one part (the indirect portion) being supero-external, and the other (the direct portion) infero-internal, and the vessels divided between, in order to substitute a single for a double sac. When the site of rupture has been exposed, a finger should be introduced through the neck of the opening and the condition of the posterior wall of the inguinal canal examined, that the operation may be planned to reinforce all sites of weakness. Cases in which well defined, sharply limited sacs exist, are more readily and satisfactorily dealt with than are those in which a general, ill-defined bulge, or weakness is present. The special method of closure intended, may have to be modified to meet the individual circumstances — and such adjacent tissues as the rectus muscle, and the muscular aponeuroses are extensively used, for the purpose of strengthening the opening by apposition over it. The technical procedures for counteracting direct hernia are not as easy, satisfactory, or well defined as in the case of indirect or oblique inguinal hernia. Nor is it always possible to definitely tell, until the parts are actually exposed in the wound, whether one is dealing with a direct or an indirect hernia.

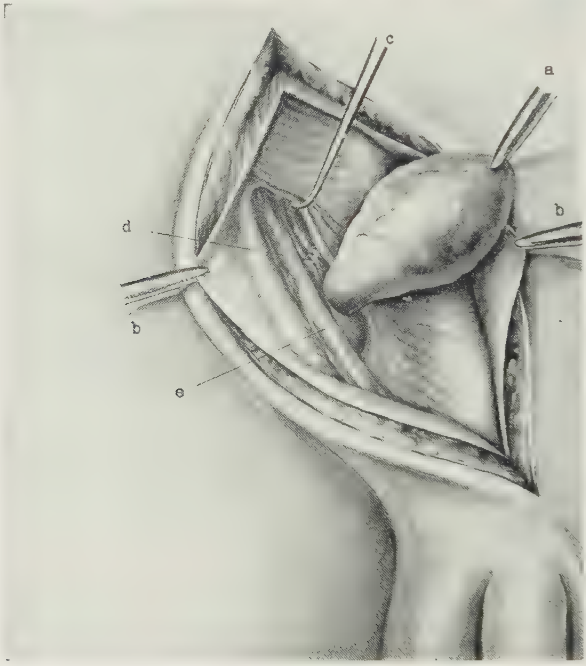


Fig. 3411.—Operation for the Radical Cure of Direct Inguinal Hernia — I: — **a,** Hernial sac; — **b, b,** retracted borders of the split external oblique; — **c,** upwardly and inwardly retracted lower borders of the internal oblique and transversalis; — **d** deep epigastric vessels, seen through the transversalis fascia.

Operation.—The hernial site is exposed by an incision placed directly over the axis of the hernia — beginning well above its neck, and passing as far down over its course as indicated (Fig. 3389, **b**). The internal oblique and transversalis muscles are retracted, by means of a small retractor applied at the internal ring _ and the muscles followed downward and inward, to their junction with the transversalis fascia, at the outer border of the rectus muscle (Fig. 3411). The aponeurotic sheath of the rectus muscle is incised, and the rectus muscle is exposed down to its pubic insertion. Poupart's ligament is now freed and retracted and the outer margin of the rectus muscle is sutured to the shelving border of this ligament, by three or four kangaroo-tendon stitches, carried from below upward, and 1.3 cm. (½ inch) apart (Fig. 3412). When all of the sutures have been placed, the border of the rectus muscle and Poupart's ligament are held together by an Assistant, while sutures are tied in the order inserted.

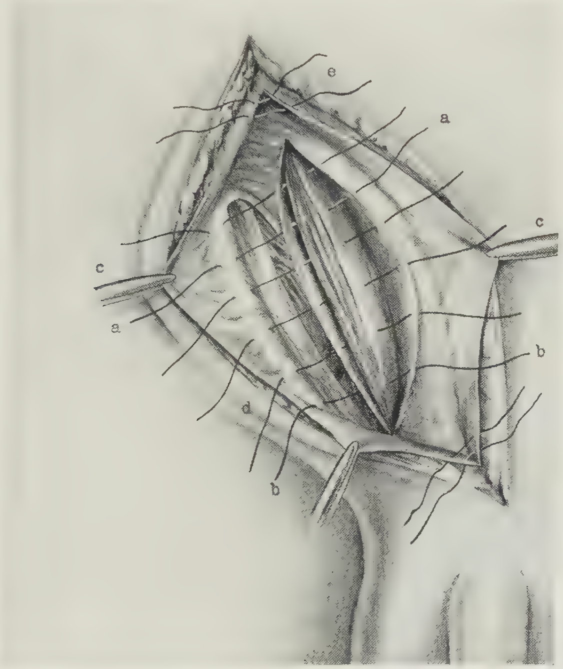


Fig. 3412.—The Same _ II: _ **c, c,** Retracted margins of the split external oblique; _ **a, a,** and **b, be** sutures approximating the margins of the freed rectal sheath and the split outer margin of the rectus, above and inward, to the shelving border of Poupart's ligament, below and outward, covering over the cord, which is seen beneath the sutures; _ **e,** sutures approximating the split margins of the external oblique. The hernial sac has been treated in the usual manner, and its stump returned to the abdominal cavity.

The internal oblique and transversalis are then dropped by the retractor _ and the ordinary Bassini operation performed, from above downward. The first row of these sutures attaches the internal oblique and transversalis to that portion of Poupart's ligament just superficial to the row of sutures binding rectus and Poupart, and placed so as to fall above and between those sutures. The split margins of the external oblique are then sutured together in the usual manner.

Three separate layers are thus formed, as protective barriers at the weakened site _ where sometimes the posterior wall of the inguinal canal is absent.

The spermatic cord is always transplanted.

If the cremaster muscle be strong and substantial, it is included by the sutures binding rectus to Poupart _ but if insignificant, it may be cut away.thus

Downes, who has reported more than 50 cases of direct inguinal hernia operated upon, formerly split the aponeurosis of the rectus upon its upper surface, and turned it down with the muscular fibers, and sutured it to Poupart's ligament _ but often the lower part of the muscle proved so thin, that the incision passed through, and when the sutures were placed, a weak, triangular-shaped area was left in the muscle.

Comment.—It is a fact worthy of note _ as well as just criticism _ that, in general, in special works upon the subject of Hernia, the methodical description of direct inguinal hernia is practically unknown. In the careful survey of many domestic and foreign works upon this special branch of Surgery, the writer has not found one creditably given description of an operation for this important and very-difficult-to-deal-with type of hernia.

FEMORAL HERNIA

SURGICAL ANATOMY

The structures encountered in the operations for Femoral Hernia, and those in the immediate neighborhood of the site of operation, will be here briefly described, chiefly as encountered, from without inward.

Superficial Fascia.—Between whose layers are superficial arteries, veins, lymphatics, and nerves.

Superficial Layer of Superficial Fascia.

Superficial Arteries.—Superficial external pudic; superficial epigastric; superficial circumflex iliac _ all from the femoral.

Superficial Veins.—Internal or long saphenous _ receiving superficial external pudic, superficial epigastric, and superficial circumflex iliac.

Superficial Inguinal Glands.—Superior set _ along Poupart's ligament. Inferior set _ around saphenous opening.

Superficial Nerves.—Ilio-inguinal; crural branch of genitocrural.

Deep Layer of Superficial Fascia.—Cribriform fascia _ that portion attached to the borders of the saphenous opening, in the fascia lata.

Fascia Lata.—Iliac portion _ outer portion of fascia lata. Pubic portion _ inner portion of fascia lata.

Saphenous Opening.—Opening in fascia lata formed by iliac and pubic portions uniting _ through which opening a femoral hernia escapes after traversing the crural canal. (See Fig. 3368.)

Poupart's Ligament or Crural Arch.—See Inguinal Hernia.

Gimbernat's Ligament.—See Inguinal Hernia.

Crural or Femoral Sheath.—Formed by continuation downward of transversalis fascia in front and iliac fascia behind the femoral vessels _ the two layers being united and continuous directly to the outer side of the vessels; but at a short distance from these vessels, upon the inner side, a space intervenes, usually occupied by a lymphatic gland, between the femoral vein and the inner limit of the sheath, constituting the crural or femoral canal. The femoral sheath is redundant and funnel-shaped opposite Poupart's ligament, but is adherent to the areolar sheath of the femoral vessels about 2.5 cm. (1 inch) below the saphenous opening.

Relations of Crural or Femoral Sheath.—Anteriorly: _ iliac portion of fascia lata. Posteriorly: _ pubic portion of fascia lata. Externally: _ genitocrural nerve pierces. Internally: _ internal saphenous vein and lymphatics pierce.

Septa of Crural or Femoral Sheath.—Outer anteroposterior septum _ between femoral artery and femoral vein. Inner anteroposterior septum _ between femoral vein and femoral canal.

Compartments Within Crural or Femoral Sheath.—Three compartments are formed by the two above septa. Outer compartment is occupied by femoral artery. Middle compartment _ by femoral vein. Inner compartment _ constitutes femoral canal _ which is generally filled up by lymphatic glandular and areolar tissue in the normal state.

Deep Crural Arch.—A thickened portion of fascia transversalis, passing from center of Poupart's ligament, across the anterior aspect of the crural sheath, to be attached to the pectineal line posterior to the conjoint tendon.

Crural or Femoral Canal.—Space between femoral vein and inner wall of femoral sheath _ that is, the inner compartment of the sheath of the femoral vessels. Anterior wall _ formed by transversalis fascia covered by falciform process of iliac portion of fascia lata. Posterior wall _ formed by iliac fascia, resting upon pubic portion of fascia lata. External wall _ formed by internal septum between it and femoral vein. Internal wall _ formed by union of transversalis and iliac fasciæ bounding the femoral canal and resting against the base or outer border of Gimbernat's ligament. Upper opening of femoral canal _ is the femoral or crural ring, and is closed by the septum crurale (condensed areolar tissue). Lower opening of femoral canal _ is the saphenous opening, and is closed by the cribriform fascia.

Crural or Femoral Ring.—Superior opening of the femoral canal into the peritoneal cavity _ oval, transverse in direction, about 1.3 cm. (½ inch) in extent _ and having following boundaries: _ Anteriorly: _ Poupart's ligament; deep crural arch. Posteriorly: _ os pubis; pectineus; pubic portion of fascia lata. Internally: _ external border of Gimbernat's ligament; conjoint tendon; transversalis fascia; deep crural arch. Externally: _ inner anteroposterior fibrous septum on inner aspect of femoral vein.

Relations of Structures in the Near Neighborhood of the Ring.—Superiorly: _ spermatic cord in male (round ligament in female); deep epigastric vessels. Externally: _ femoral vein; deep epigastric vessels. Anteriorly: _ communicating branch between deep epigastric and obturator arteries. Internally: _ no important structure. Posteriorly: _ no important structure.

Obturator Artery.—Arises in common with deep epigastric once in every three and one-half subjects _ and in such cases it follows one of two courses: _ (1) Runs down upon inner aspect of external iliac vein, along the outer side of crural ring _ and is, therefore, in safety. (2) Runs along free border of Gimbernat's ligament, along the inner side of crural ring _ and, therefore, is apt to be cut in an outward incision for relief of stricture.

Septum Crurale.—Condensed areolar tissue closing upper opening of femoral ring.

Subperitoneal Areolar Tissue.

Peritoneum.

GENERAL SURGICAL CONSIDERATIONS

Course of Femoral Hernia.—Coming from within the abdominal cavity outward, the hernia passes at first vertically through the femoral canal, from the femoral ring to the saphenous opening _ thence (because the femoral sheath here narrows and is more closely connected to the vessels, and because of the closer connection of superficial fascia and crural sheath to the saphenous opening) forward through the cribriform fascia _ thence upward upon the falciform process of the fascia lata and Poupart's ligament. In manipulation for the reduction of such a hernia, pressure should be applied in the reverse directions.

Coverings of Femoral Hernia.—Passing from within outward, the hernia carries with it the following structures, in order: _ (1) Within the abdomen: _ peritoneum; subserous areolar tissue. (2) At femoral ring: _ septum crurale.

(3) In femoral canal: _ femoral sheath. (4) At saphenous opening: _ cribriform fascia. (5) Upon thigh: _ superficial fascia; skin.

Seats of Stricture.—(1) At the border of the saphenous opening; _ (2) At the union of the falciform process of the fascia lata and the curved edge of Gimbernat's ligament; _ (3) At the femoral ring.

Direction of Division of Stricture.—Upward and inward _ for 4 to 6 mm. (2–3 lines).

OPERATION FOR THE RADICAL CURE OF FEMORAL HERNIA

BASSINI'S METHOD

Description.—The hernial sac is exposed, emptied of contents, ligated, excised, and the neck returned to the abdominal cavity. The femoral canal is then closed by suturing Poupart's ligament and the falciform process of the fascia lata, above and externally _ to the pectineal fascia (pubic portion of fascia lata) below and internally.

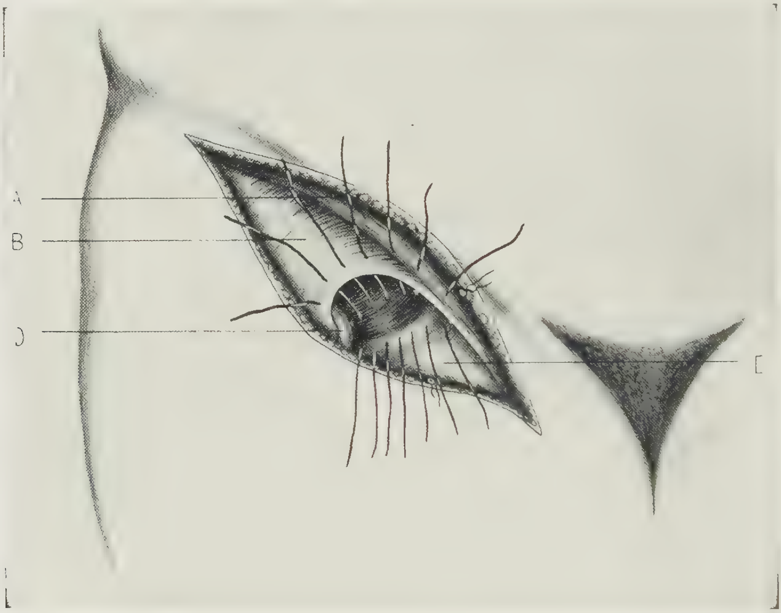


Fig. 3413.—Bassini's Operation for Femoral Hernia: _ A, Poupart's ligament; B, falciform process of fascia lata; C, pectineal fascia (pubic portion of fascia lata); D, internal saphenous vein. Three sutures to right approximate Poupart's ligament to pectineal fascia. Remaining sutures pass through falciform process of fascia lata externally, and the pectineal fascia internally. (Note _ the femoral opening is represented somewhat too far outward.)

Preparation.—Pubic region and region of the saphenous opening shaved.

Position.—Patient supine at edge of table. Surgeon on side of hernia. Assistant opposite.

Anesthesia _ Analgesia.—The former is preferable. The points of injection in the latter are shown in Fig. 3369.

Landmarks.—Poupart's ligament, femoral vessels; saphenous opening.

Incision.—Parallel with and just below Poupart's ligament, with its center over the saphenous opening. (See Fig. 3389, c.)

Operation.—Incise the skin and superficial fascia _ clamp and tie the vessels _ retract the edges of the wound _ and expose the saphenous opening. Dissect out the hernial sac from its canal, as high up as possible. Open its lower part and return its contents to the abdominal cavity. Draw the sac well down and transfix its neck with double chromic ligature. Cross the ends of the ligatures and ligate and cut off the neck safely below the ligature _ the stump receding into the abdomen.

Pass kangaroo-tendon, or chromic gut sutures, in a curved needle, in the following manner: _ (*a*) Pass three sutures to approximate Poupart's ligament to he pectineal fascia _ the first, near the pubic spine _ the second, about 5 mmt (nearly $\frac{1}{4}$ inch) to the outer side of the first _ and the third, about 1 cm. ($\frac{3}{8}$ in.ch) to the inner side of the femoral vein _ each passing through the pectineal fascia below (Fig. 3413). These sutures are left temporarily untied. (*b*) Pass three or four other sutures through the falciform process of the iliac portion of the fascia lata, externally _ and the pectineal fascia (which is the same as the pubic portion of the fascia lata) internally _ the lowest suture passing just above the saphenous vein. The upper sutures are then tightened and tied, bringing Poupart's ligament backward to the linea pectinea. The lower sutures are next tightened and tied, approximating the anterior and posterior walls of the femoral canal.

The skin incision is closed with silk. No drainage is used.

OPERATION FOR THE RADICAL CURE OF FEMORAL HERNIA

KOCHER'S TECHNIC

Description.—The principle of the operation here described is based upon the provision for the removal of the sac high up, rather than at its site of exit, which is easier to accomplish, owing to the shortness of the crural canal, than in inguinal hernia. An attempt is also made to artificially extend Gimbernat's ligament in the direction of and up to the femoral vein. Owing to the inability of securing the broad support which is available in inguinal hernia, the radical cure of femoral hernia while, in some cases, is very easily and simply brought about, is, at other times, difficult. In the larger, more complicated, obstinate types of femoral hernia, various plastic procedures have been carried out _ and are to be devised in accordance with the needs of the particular case.

Operation.—In the case of small and medium-sized femoral herniæ, the following technic is carried out: _ An incision is made over the inner third of Poupart's ligament _ incising through skin, superficial fascia _ and that part of the fascia lata which covers the saphenous opening (cribriform fascia). Free the hernial sac by blunt dissection _ especially removing the fatty connective tissue _ so that the sac can be cleared up to the crural ring, through which it has made its exit, after having protruded, or pierced the septum crurale and fascia transversalis lying between the sharp external border of Gimbernat's ligament and the femoral vein. The contents of the hernial sac are reduced, with or without incising the sac (though the latter is invariably better policy) _ ligated _ and excised.

In those cases in which the hernial sac cannot be freed sufficiently high up, Kocher treats the sac by transposition and invagination _ as in the inguinal variety of hernia. The contents of the sac are first reduced _ and then the apex of the sac is seized with a pair of transposition-forceps and invaginated _ the forceps are being carried upward, just behind Poupart's ligament to the anterior abdominal wall _ where they are protruded through a small incision made in the outer pillar of the external abdominal ring. After this, the projecting sac is grasped with forceps and drawn out _ its base transfixed and tied – and the sac excised (Fig. 3414). The stump of the sac is then buried, and the aponeurotic incision closed.

Finally, the ring through which the hernia made its exit is closed – independently of which of the above methods of disposing of the sac was employed. The inner aspect of the femoral vein is located, so as to guard it against injury in the subsequent manipulations – and a silk suture is carried upon a curved needle (or, better, upon a Reverdin needle) so as to approximate the pectineal fascia and the deep crural arch (the ligament of Cooper, which is a strong fascial layer prolonged outward from Gimbernat's ligament). This suture is then tensed, to see that it accomplishes the purpose. If another suture be necessary, it is carried directly to the bone, before tying the first suture. The needle (which has been left threaded) is now carried through Poupart's ligament (and the second suture also, if two be used) and firmly tied. The inner aspect of Poupart's ligament is thus anchored to the pectineal fascia – thereby securely closing the femoral ring. The fascial and cutaneous wound is then closed in the usual manner.

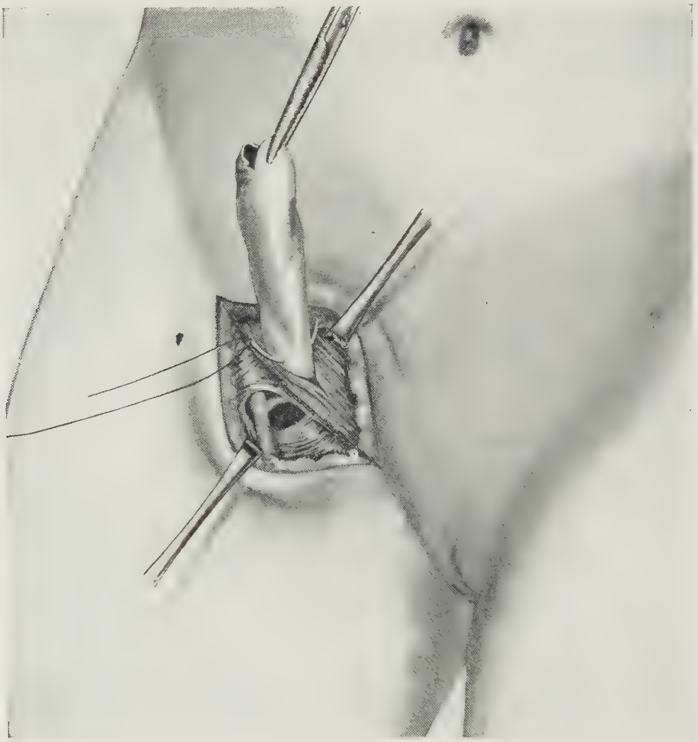


Fig. 3414.—Kocher's Operation for the Radical Cure of Femoral Hernia by the Transposition Method: The hernial sac is here shown drawn upward and outward, through an incision in the outer pillar of the external abdominal ring – from the crural opening. The neck of the sac is being transfixed just above Poupart's ligament, preparatorily to ligation and excision.

OTHER OPERATIVE PROCEDURES FOR THE RADICAL CURE OF FEMORAL HERNIA

The closure of a femoral hernia may be accomplished through a purse-string suture of the opening – as seen in Fig. 3415. Kangaroo-tendon, upon a curved

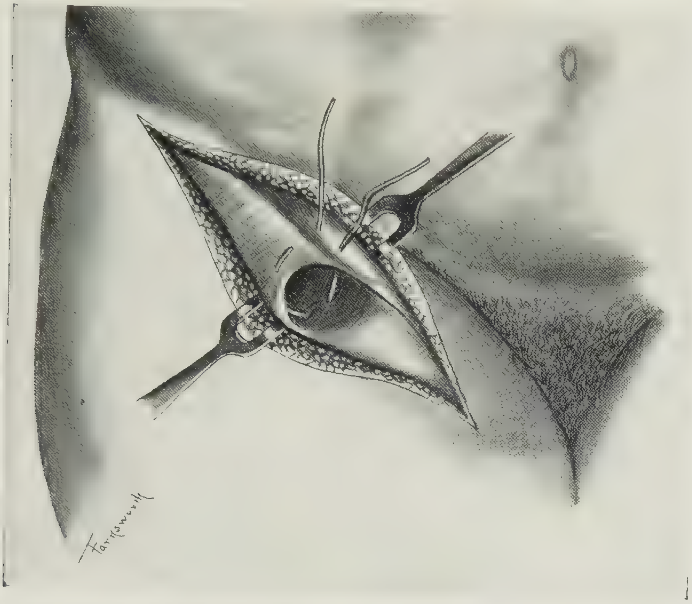
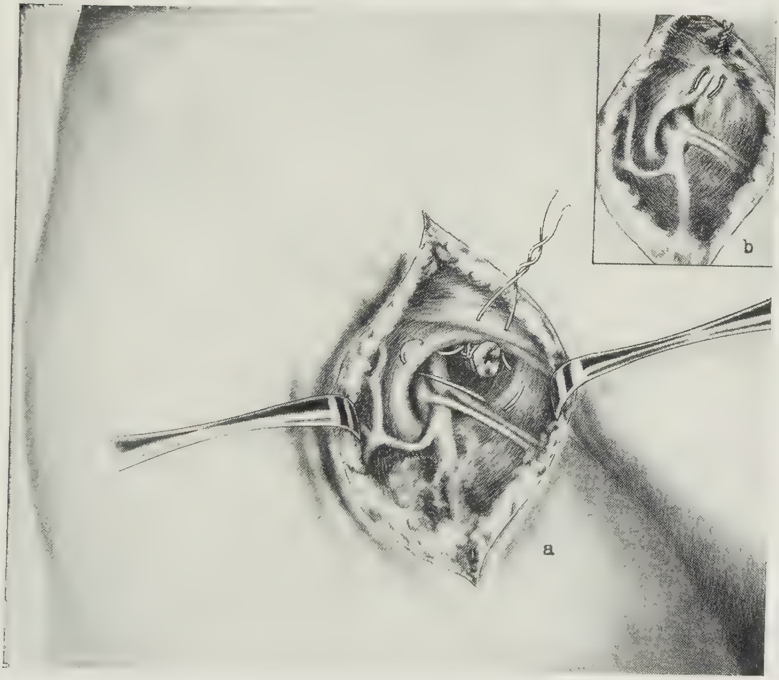


Fig. 3415.—CLOSURE OF THE FEMORAL CANAL BY A PURSE-STRING SUTURE.



Figs. 3416 and 3417.—CUSHING'S OPERATION FOR THE RADICAL CURE OF FEMORAL HERNIA: — **a**, Kangaroo-tendon suture is carried through the inner aspect of Poupart's ligament, the roof of the canal — thence downward, through the pectineal fascia and muscle — thence outward, through the fascia lata lying over the femoral vein — thence through the roof of the femoral canal — to emerge upon the outer aspect of Poupart's ligament — over which the two limbs of the suture are tied; **b**, the tied suture approximates in a slightly oblique axis, the roof and floor of the femoral canal.

needle, is passed through the inner aspect of Poupart's ligament, forming the roof of the canal _ thence downward, taking a firm hold upon the pectineal fascia and underlying muscle _ thence outward and upward, through the fascia lata, covering the femoral vein _ thence on upward, coming out through the roof of the femoral canal, about 6 mm. (1/14 inch) from its place of entrance.

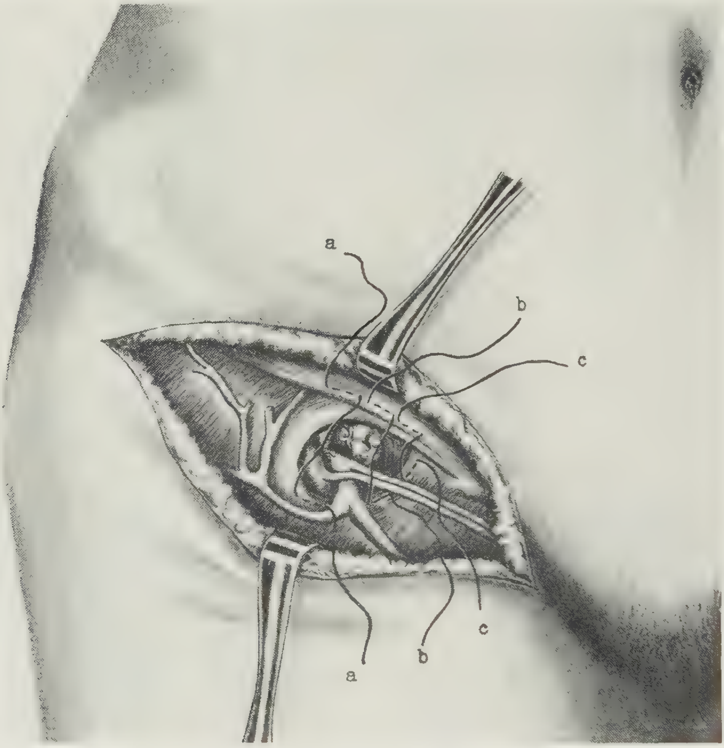


Fig. 3418.—Ferguson's Operation for the Radical Cure of Femoral Hernia; _ Within the dissected saphenous opening are seen the ligated neck of the hernial sac and branches of the femoral vein and artery. Three "inversion sutures," **a, a** _ **b, b** _ and **c, c** _ are seen passing through the pectineal fascia and muscle, close to the pubic bone _ and then grasping Poupart's ligament _ placed in such manner as to cross like the limbs of an X when tied _ and tied in such a manner as to close the saphenous opening, from below upward, in a transverse direction.

When the suture is tied the floor of the femoral canal is brought up into contact with its roof, thus obliterating the femoral opening.

Cushing's method of repairing femoral hernia is pictured, and briefly described, in Figs. 3416 and 3417.

Ferguson's technic is given in Fig. 3418.

Taylor's method is seen in Fig. 3419.

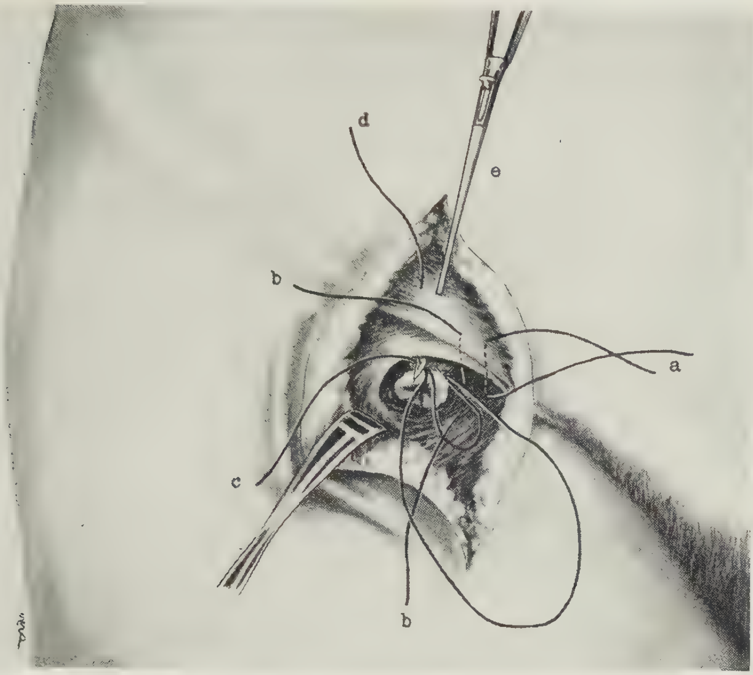


Fig. 3419.—Taylor's Operation for the Radical Cure of Femoral Hernia; – The structures of the saphenous opening are freed and removed – the sac of the hernia is exposed, incised, emptied, and ligated. A Reverdin needle, **e**, or other special needle, passing through Poupart's ligament from above, brings upward, through the roof of the femoral canal, each of the two limbs of the ligature, **d** and **c**, which has constricted the neck of the sac – thus displacing the stump upward and, upon knotting, anchoring it. The femoral canal is closed by two sutures, **a** and **b**, which approximate Poupart's ligament, the roof of the canal, to the pectineal fascia and muscle, the floor of the canal.

OPERATION FOR STRANGULATED FEMORAL HERNIA

Description.—The object here sought is twofold – providing the condition of the patient permits it, – the relief of strangulation – and the radical cure of the hernia.

Operation.—A vertical incision of about 7.5 cm. (3 inches) is made, beginning 2.5 cm. (1 inch) above Poupart's ligament, and extending downward over the tumor. As the hernial sac may lie very superficially, this incision should be carefully made and deepened. When the sac is approached, the lips of the wound should be retracted, and the sac itself freed by blunt dissection. After isolation of the sac, it is carefully incised – using more than ordinary care, as the incarcerated bowel is often under very great tension, and, under such circumstances, is particularly apt to be wounded. Once the opening into the sac is made, it is more safely enlarged with blunt-pointed scissors.

It will sometimes be possible to at once draw down a further length of intestine, so as to examine the condition of the gut at the site of constriction. In other instances, the degrees of constriction will forbid this. Unless the intestinal coil can be readily and safely manipulated, the constricting ring should be at once divided. This is accomplished by dividing Gimbernat's ligament in a direction upward and slightly inward – either by passing a probe-pointed knife between the hernial sac and the constricting ring, and carefully and limitedly cutting in the direction mentioned – or by making the division by careful nicks of the scissors. Still more room may be required, and, if so, a finger is introduced alongside of the sac, and the probe-pointed knife upon the finger. Or the sac may be first further divided to its neck with scissors, followed by the drawing out of additional intestine. It is very necessary to proceed with great caution at the neck of the sac, especially when adhesions exist, as it is under these circumstances that the bowel is most apt to be damaged.

If the bowel be viable, it is carefully returned to the abdominal cavity, after which the sac is ligated and excised. If doubtfully viable, it may be left in the wound for several hours, to determine its condition. If non-viable, the damaged portion is excised, and some form of entero-enterostomy performed.

In all instances where it is possible the operation for the relief of strangulation should be immediately followed, while the patient is upon the table, by some form of procedure for the radical cure of the condition in connection with which the strangulation occurred. Several radical operations for femoral hernia have been already considered. Ferguson's method of closing the femoral canal is shown in Fig. 3418.

OPERATION FOR THE CURE OF DIAPHRAGMATIC HERNIA

Description.—Hernia of the abdominal contents through the diaphragm may be either congenital or acquired. The acquired cases are either pure diaphragmatic herniæ, where a complete peritoneal sac exists, or false diaphragmatic herniæ, in which there is no sac, and which are always traumatic. In the true herniæ, a second serous sac is formed by the overlying pleura. The false, or traumatic diaphragmatic herniæ may probably more correctly be classed as prolapses.

The sites at which diaphragmatic herniæ are most apt to occur, are the following: the central tendon (the most frequent), postero-inferior muscular portion, opening of the superior epigastric artery, opening of the musculophrenic artery, sympathetic trunk opening, opening of a branch of the internal mammary artery, the esophageal hiatus, hiatus of the aorta (really behind the diaphragm), sternocostal fissures, lumbocostal fissures, opening for the vena cava, psoas muscle opening, opening of the quadratus lumborum muscle, the foramen of Bochdalek. In addition to these, there may be other sites through which congenital herniæ appear and traumatic herniæ or protrusions may occur at any site.

Operation.—Two routes of approach are available, in dealing with diaphragmatic hernia the transpleural and the transperitoneal.

The transpleural route is being more frequently employed now than formerly since the introduction of positive pressure insufflation anesthesia, and the cabinet-differential pressure methods which have been fully described under intrathoracic operations (pp. 781–797). In approaching through the thorax, better access to the tumor is secured and freer general operative manipulation. The method of approach is usually through major intercostal thoracotomy (p. 822). If the case be one of false hernia, the tumor will have no peritoneal covering, and will be exposed as soon as the diaphragmatic pleura is incised. If it be a true hernia, it will be covered by two serous membranes the diaphragmatic pleura and the peritoneum. The same general principles apply here as when dealing with herniæ elsewhere the herniated structure is freed from the ring, or opening through which it has entered the thorax, and in connection with which it may be held by adhesions after which the integrity of the part must be determined beyond all peradventure before it is returned to the abdominal cavity. The sac is incised and, after the return of its contents, its redundant portions are trimmed. The opening in the diaphragm is now dealt with. Interrupted sutures are carried through its margins, passing through pleura, endothoracic fascia, diaphragm, diaphragmatic fascia, and peritoneum. Finally, the involved lung is fully expanded under the differential pressure method being employed _ and the thoracic wound closed. The question of drainage will have to be determined by the circumstances of the individual case and the course of the operation _ but, as a rule, is omitted.

In the trans-peritoneal operation, the best method of approach is through a temporary resection of the costal arch.

OPERATION FOR THE CURE OF OBTURATOR HERNIA

Description.—An obturator hernia protrudes through the obturator canal (which transmits the obturator vessels), an opening in the upper and outer part of the obturator membrane, which fills the obturator foramen in the os innominatum _ the hernia passing thence into the upper part of the thigh. The coil of intestine forces the parietal peritoneum through the obturator canal _ carrying the extraperitoneal tissue and pelvic fascia before it, into the region of the thigh _ whence it passes upward and forward, above the upper border of the obturator externus muscle, so that it comes to lie behind the pectineus. Sometimes the hernia forces itself between the obturator externus and the obturator membrane. The obturator artery and nerve are sometimes displaced so that they lie anterior to the hernia, or they may be posterior to the sac _ but they are generally to its outer side. The obturator canal is occupied by a prolongation of the pelvic fascia _ is covered internally by peritoneum _ and externally, by the pectineus muscle.

Obturator hernia occurs, most frequently, in elderly women. The hernia is usually small _ and is generally not diagnosed until the abdominal cavity is opened.

Operation.—It is difficult to deal with an obturator hernia through an external operation _ owing to the great depth of the opening _ and, in the case of strangulated hernia, the difficulties which may be encountered on account of the obturator vessels. The best method of approach, therefore, is through an abdominal section, with the patient in the Trendelenburg position. The involved loop of intestine after the retraction of the neighboring structures is manually delivered from the obturator opening _ which is usually readily possible, from within the abdomen, unless there be adhesions or incarceration. If the latter be present the oburator ring will have to be incised. The hernial (peritoneal) sac is then withdrawn, and split _ in order to gain access to the obturator opening in the transversalis fascia. This opening is to be closed by interrupted sutures of silk, linen, or kangaroo-tendon. The sac is then excised and the peritoneum closed.

Comment.—The abdominal section may be made in the semilunar line of the involved side.

What has been said in connection with strangulation in other forms of hernia, applies here. In withdrawing a coil of strangulated hernia, provision must be made to prevent soiling of the peritoneal cavity, in case the gut should give away.

While the obturator artery is usually a branch of the internal iliac, and lies behind, or external to the neck of the hernial sac _ it may arise from the deep epigastric, or from the external iliac, and, in such cases, lie in front of the hernial neck.

CHAPTER LXIV

OPERATIONS UPON THE PERITONEUM

Surgical Anatomy of the Peritoneum, p. 200; _ General surgical considerations in operations upon the peritoneum, p. 202.

Paracentesis Abdominis, p. 202; _ Operations for the separation or division of peritoneal adhesions, p. 203

Operative Treatment of Localized Septic Peritonitis, p. 206; _ Operative treatment of diffuse septic peritonitis, p. 207; _ Operation for intraperitoneal abscess, p. 215.

SURGICAL ANATOMY OF THE PERITONEUM

Course of the Peritoneum Forming the Greater Sac _ In Longitudinal Section.—Passing down from the umbilicus, the peritoneum lines the anterior abdominal wall _ covers the urachus and obliterated hypogastric arteries _ passes on to the bladder, from its upper aspect to the trigone _ is reflected on to the anterior and upper part of the lateral aspects of the rectum, in the male, forming the rectovesical pouch. In the female the reflection is from the bladder on to the uterus (uterovesical fold) _ extending thence over the upper portion of the posterior vaginal wall _ and thence to the rectum (rectovaginal pouch). From the rectum the sigmoid flexure of the colon is entirely covered (sigmoid mesocolon) _ the ascending and descending colons being covered, generally, only anteriorly and laterally _ and passing from the spine downward, the peritoneum covers the small intestines, forming the lower leaf of the mesentery _ and thence back again, completing the investment of the small bowel, forming the upper leaf of the mesentery _ and passes backward over the transverse portion of the duodenum to the pancreas _ thence forward to form the inferior layer of the transverse mesocolon _ covers the inferior and part of the anterior aspect of the transverse colon _ thence runs downward to form the posterior layer of the great omentum _ returning to form the anterior layer of the great omentum _ thence to the stomach, covering its anterosuperior aspect _ thence to the under surface of the liver, forming the anterior layer of the lesser or gastrohepatic omentum _ thence covers the inferior surface of the liver, from the transverse fissure to its anterior border _ whence it is reflected over the anterior border to cover the superior surface of the liver to the posterior peritoneal limit _ thence it passes to the inferior concave surface of the diaphragm (superior layer of the coronary ligament) _ thence over the anterior portion of the concavity of the diaphragm to the anterior abdominal wall _ whence it passes down the anterior abdominal parietes to the umbilicus, to the place of beginning.

Course of the Peritoneum Forming the Lesser Sac _ In Longitudinal Section.—Beginning at the posterior aspect of the stomach, which it covers, the peritoneum of the lesser sac passes upward to the inferior surface of the liver, behind the transverse fissure, forming the posterior layer of the lesser or gastrohepatic omentum _ and having covered the postero-inferior aspect of the liver, it passes on to the under surface of the diaphragm (inferior layer of the coronary ligament) _ thence passes downward over the posterior portion of the concavity of the diaphragm to the spine, covering the great vessels _ thence to the pancreas _ thence forward, forming the upper layer of the transverse mesocolon _ covers the supero-anterior aspect of the transverse colon _ descends, forming the innermost layer of the great omentum _ then ascends to the greater curvature of the stomach – and covers its posterior wall, to the place of beginning. The lesser sac is in relation with the inner aspect of the spleen, forming the inner layer of the gastrosplenic omentum – and also in relation with the superior portion of the left kidney.

Layers and Folds of Peritoneum.—(1) Parietal Layer – connected by subperitoneal areolar tissue with the walls of the abdominopelvic cavity. (2) Visceral Layer – covers some part, or the entire surface, of all the viscera of the abdominopelvic cavity. (3) Mesenteries – folds of peritoneum connecting parts of the intestinal tract with the posterior abdominopelvic wall. (4) Omenta – folds of peritoneum connecting the stomach with other viscera. (5) Ligaments – reflections of peritoneum from parts of the abdominopelvic walls and diaphragm to the various abdominopelvic viscera other than the intestines – for example, those of the liver, spleen, uterus, etc. For these ligaments, see the various viscera of the abdominopelvic region.

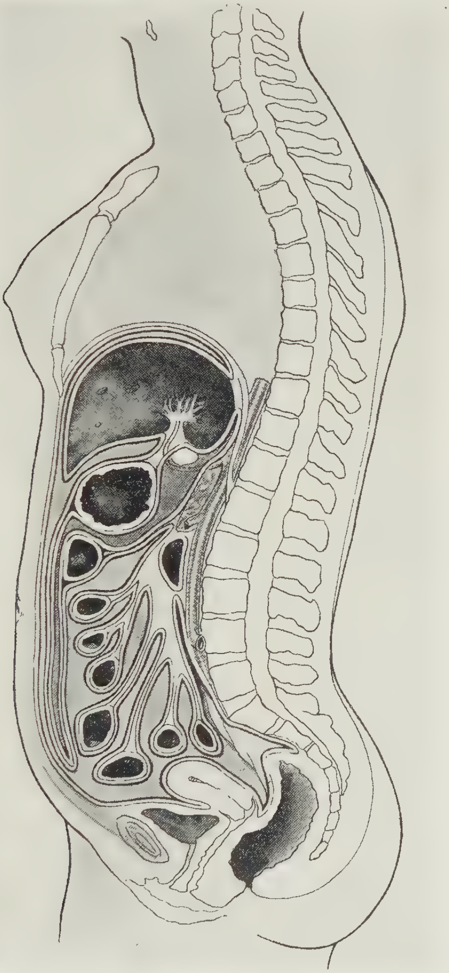


Fig. 3420.—Sectional View, in the Sagittal Plane, of the Abdominopelvic Cavity – and the Reflections of the Peritoneum. (Redrawn from various Anatomies.)

Foramen of Winslow.—Communication between the greater and lesser peritoneal sacs _ revealed by lifting the liver upward and to the right, and depressing the first part of the duodenum and intestines downward and to the left. Bounded: _ Superiorly; by caudate lobule of liver; _ Inferiorly; by first part of duodenum and first part of hepatic artery; _ Anteriorly; by ligamentum hepatoduodenale (right free edge of lesser omentum), with its contained ductus communis choledochus, vena portæ, and hepatic artery, in order from right to left _ the vena portæ lying somewhat posterior to artery and duct.

Viscera Almost Entirely Covered by Peritoneum.—Liver; stomach; spleen; first portion of duodenum; jejunum; ileum; transverse colon; cecum; sigmoid flexure of colon; upper half of rectum; uterus; ovaries.

Viscera Partly Covered by Peritoneum.—Descending and transverse parts of duodenum; ascending and descending colons; midportion of rectum; upper part of vagina; posterior wall of bladder.

Viscera in Contact with Peritoneum Without Being Especially Covered by It.—Kidneys; suprarenal capsules; pancreas.

Viscera Uncovered by Peritoneum.—Lower end of rectum; neck, base and anterior aspect of bladder; anterior and inferior portion of posterior wall of vagina.

GENERAL SURGICAL CONSIDERATIONS IN OPERATIONS UPON THE PERITONEUM

Where the peritoneum is attacked surgically it is generally dealt with incidentally, as a part of some special operation. The technic, therefore, of dealing with the peritoneum is described in those special operations. In some cases, however, the peritoneum is the structure primarily dealt with _ and will be so considered in the present section.

The surface form and landmarks of the peritoneum, as well as the instruments used, are sufficiently given under the operations upon the abdominal wall and the viscera of the abdominopelvic cavity.

PARACENTESIS ABDOMINIS

Description.—Puncture of the peritoneal cavity for diagnostic purposes, or for evacuation of peritoneal fluid.

Preparation.—Shave the abdominal wall. Empty the bladder and bowels. The area of dulness is to be verified by percussion immediately before paracentesis. The area of puncture is analgesized.

Position.—Patient, where possible, sits upright in chair _ where impossible, lies upon edge of bed. A many-tailed, sterilized bandage, or ordinary towel, with a central opening corresponding to the site of paracentesis, is placed around the patient, and tightened posteriorly by an assistant as the abdominal enlargement decreases with the evacuation of fluid. Surgeon sits immediately in front of patient. This posture throws the fluid forward.

Landmarks.—Linea alba; umbilicus; limit of upper aspect of bladder (q. v.).

Special Instruments.—For exploratory punctures, aspiratory syringes with needles of small caliber. For evacuation of considerable quantity of fluid, a straight cannula and trocar of fairly large size is used. Aspirators of the Dieulafoy and Potain type may be employed. Where the skin is to be preliminarily incised, a knife is necessary _ and a needle and thread, where the incision, or trocar-wound, is to be closed by suture.

Site of Paracentesis.—Generally in the linea alba, midway between umbilicus and symphysis pubis. Sometimes the puncture is made in the lower half of either semilunar line.

Operation.—Having so placed the broad bandage that the opening is opposite the site of paracentesis, and having grasped the exploratory or aspiratory needle, or trocar, in such a way as to predetermine, by means of the right index, the depth to which it is to enter, which will be decided by the estimated thickness of the abdominal wall, the instrument is quickly but guardedly thrust through the abdominal wall into the free peritoneal cavity, in a single movement. In the case of the exploratory syringe, sufficient fluid is withdrawn for examination _ the needle withdrawn, and the wound closed with collodion and cotton.

In the case of the evacuation of large amounts of fluids by means of cannula and trocar (or aspirator) the trocar is withdrawn and the cannula left *in situ* _ the fluid is then allowed to flow, the bandage being tightened *pari passu.* At the end of the operation, the cannula is withdrawn _ and, if it have been of large size, an interrupted gut suture is made to close the opening by being passed on a curved needle, from side to side, through a part of the thickness of the abdominal wall. The outer aspect of the opening is then closed with collodion and gauze, or cotton.

Comment.—(**1**) Where a large size instrument is used, it is best to make a small preliminary incision through the tough skin. (**2**) A cannula should be used the end of which is not pointed or sharp. (**3**) If the cannula be obstructed during the flow, it may generally be freed by the passage of a sterile probe down its length. (**4**) As the fluid escapes, the inner end of the cannula may be shifted so as to furnish the best evacuation. (**5**) The fluid should be made to escape slowly _ and may be retarded by a compress over the outer end of the cannula _ to avoid syncope. (**6**) Be ready for emergency laparotomy.

OPERATIONS FOR THE SEPARATION OR DIVISION OF PERITONEAL ADHESIONS

Description.—Adhesions, resulting from the union of the serous surfaces of the peritoneum, may occur in the form of thin, thick, narrow or broad sheets or membranes; _ in the form of fragile, dense, short or long bands; _ or as limited or extensive surfaces loosely or intimately united. Adhesions may be vascular or comparatively non-vascular. Adhesions may be encountered in any operation involving any serous cavity _ therefore, the special features, anatomic relations, and all steps preliminary to the discovery of the adhesions, will depend upon the operation in question.

Two general methods of dealing with adhesions are available: (**1**) By blunt dissection, with or without ligature, _ more applicable in non-vascular, loose and limited adhesions; _ (**2**) By division between ligatures, _ more applicable to vascular, firmer and more extensive adhesions. (See Figs. 3421 and 3422.)

Separation of Adhesions by Blunt Dissection, With or Without Ligation.—The underlying principle in this method of dealing with adhesions is to find the plane of cleavage in the abnormal union and follow it up, separating the adherent surfaces as carefully as possible. This separation is best accomplished by means of a blunt dissector, the handle of a knife, the closed ends of a pair of blunt scissors, or the tip of the finger. If the last be used, a better hold may be gotten upon the parts by stretching a single thickness of gauze over the finger-tip. The adhesions are gently torn apart, always endeavoring to adhere strictly to the cleavage line, especially where important structures are involved, as in the serous coverings of viscera. If the adhesions be limited and but little vascular, ligation is generally unnecessary. If they be vascular, and especially if somewhat extensive and dense, they should be ligated in two places from 1.3 to 2.5 cm. ($\frac{1}{2}$–1 inch) apart, according to circumstances and then divided between the ligatures. The preferable ligature is plain gut for small adhesions _ and chromic gut for larger ones. Adhesions are often first divided and then ligated (Figs. 3421, D and 3422, **a**).

Division of Adhesions Between Ligatures.—The adhesions are first carefully isolated _ and then treated according to their nature. If they be in the form of bands, double ligatures of chromic gut are thrown around them and tied, and the bands are then divided between them. If the adhesions be in the form of broad surfaces, they are ligated in sections and divided upon the distal side of the ligatures _ or between two ligatures, if indicated (Figs. 3421, A and 3422, **b**).

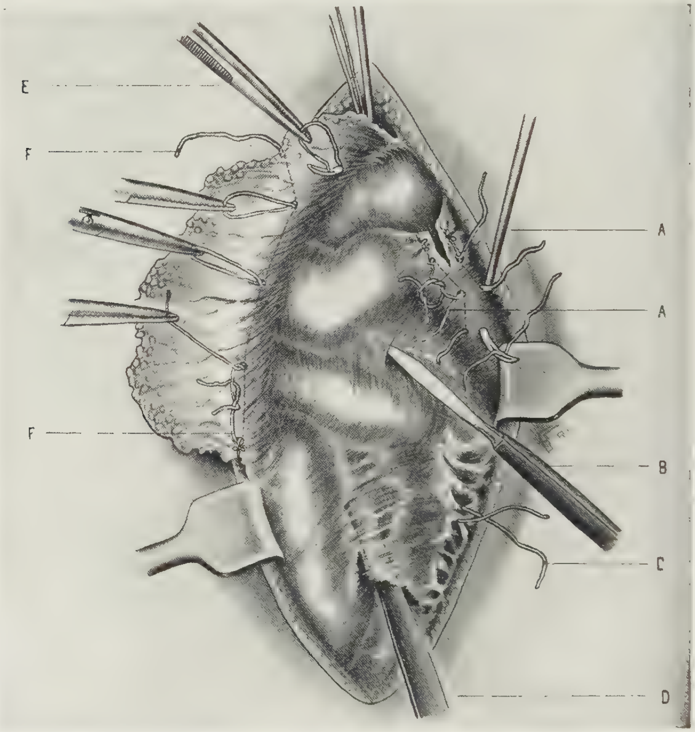


Fig. 3421.—Operations for the Separation of Peritoneal and Omental Adhesions: _ A, A, Dividing, in sections, thick layers of intestino-abdominal adhesions, between double ligatures; _ B, incising thin layers of interintestinal adhesions; _ C, ligating isolated bands of intestino-abdominal adhesions; _ D, separation of membranous interintestinal adhesions by blunt dissection; _ E, F, F, tying off, in sections, adherent omentum, preparatory to excisions of the distal portion _ E, by means of individual ligature, carried by aneurysm needle _ F, F, by means of continuous ligature applied to the posterior and drawn through the anterior aspect of the omentum in sections, by clamp-forceps.

Comments.—It often happens that severe pain, especially of a spasmodic nature, occurring within the abdominopelvic cavity _ and particularly along the course of the gastro-intestinal tract _ can be entirely and immediately relieved by making an abdominal section, and severing peritoneal adhesions which are unnaturally binding the parts. It has been found that even very frail, insignificant adhesions, when divided, will often be followed by cessation of pain at once.

It is necessary to separate the adhesions completely _ and it is very desirable that the site of separation should be covered over with healthy peritoneum _ or an omental graft. Absorbable suture material should be used.

No specific directions can be given for these cases _ each must be met upon its own grounds, after the abdomen is opened _ and the general principles of separating adhesions as described under the operation for septic peritonitis _ and pictured in Figs. 3421 and 3422 _ hold in these cases.

Visceral Adhesions to the Abdominopelvic Wall.—When entering the abdominal cavity where adhesions may be suspected, or where, in the neighborhood of known adhesions, it is uncertain as to whether the peritoneal cavity have been entered, the underlying tissues should be picked up and rolled between the fingers, to enable a judgment to be formed by the sensation imparted. If the peritoneal cavity be entered in the immediate vicinity of an adhesion, this should be at once recognized by sweeping the finger around the vicinity of the opening _ and the adhesion separated by blunt dissection, or divided between double ligatures if necessary. Where the opening made comes directly down upon adhesions, these should be recognized as soon as possible, that the progress toward the peritoneal cavity may be known _ and then an endeavor be made to reach a free margin of the adhesion, from which the remainder of the separation, or division, may be made on the general principles mentioned.

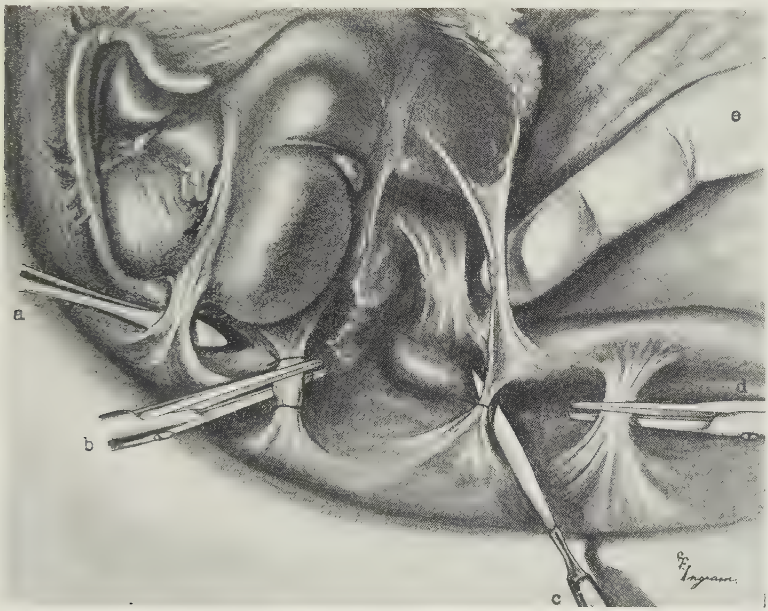


Fig. 3422.—Operations for Separation of Peritoneal Adhesions: _ **a,** By blunt dissection, with a blunt dissector; _ **b,** by scissors, between ligatures; _ **c,** by knife, after one or more ligatures; _ **d,** with scissors; _ **e,** by blunt dissection, with the finger. The density, filamentous nature, extent, vascularity, importance of adherent structures, and other similar considerations, will determine the method of separation most desirable in the particular case.

Intestinal Adhesions.—The thin, membranous or velamentous adhesions may generally be separated by blunt dissection with the fingers _ by putting the parts gently upon the stretch and keeping the adhesion in a broad, thin layer, rather than in a thick, twisted cord. Dense, organized adhesions require careful dissection _ that no part of either wall may be dangerously thinned. (See Figs. 3421 and 3422.)

Intervisceral Adhesions.—Or adhesions between growths and viscera _ should be dealt with by putting the adhesion upon moderate stretch _ by traction upon one or both viscera, until the bond of adhesion is demonstrated _ then first ligate or clamp on each side, safely to the outer side of the viscus, and divide the adhesion between the ligatures or clamps.

Omental Adhesions.—Adherent omentum may often be stripped off with the fingers. If too dense, or too firmly united for this, it should be ligated with a single ligature, or in sections, and divided. Large portions of the omentum _ and even the entire omentum _ may be amputated. The omentum may require only a proximal, or may require double ligaturing (Fig. 3421, E, F, F).

Comment.—(**1**) While the separation in the plane of the abnormal adhesion should always be the course attempted, where this is impossible it often happens that areas, dependent upon their nature, have to be ligated, or clamped, and cut, with the sacrifice of some portion of the least important structure. (**2**) Where the separation of an adhesion between viscera and neighboring structures (visceral or otherwise) is impossible, and where the step is permissable, one or more layers, or even the entire thickness, of the less important structure is left attached to the more important one _ after ligating and blunt dissection, or incision, of the adhesion _ thus leaving a limited area of adherent tissue attached to an organ, rather than risk injuring the organ by further attempt at removal. In such cases the portion left is reduced to its smallest and thinnest size. (**3**) It is always desirable to preserve the serous covering of a viscus (to aid nutrition and avoid adhesions and sloughing) _ and sometimes surfaces left raw by separating adhesions may be covered, and hemorrhage also controlled, by suturing adjacent serous surfaces over them _ or by attaching omental grafts. (See page 219.)

Note.—For further consideration of this subject, see Complications of Median Abdominal Section, page 104.

OPERATIVE TREATMENT OF LOCALIZED SEPTIC PERITONITIS

While the object in operating for both localized and diffuse septic peritonitis is twofold _ namely, the repair of the defect which caused the infection, and the removal of the results of infection _ this is especially so in the case of localized peritonitis _ for, in the latter, the process is, as yet, limited to the neighborhood of the originating cause _ while in diffuse septic peritonitis, the process has transgressed the original bounds and is at large in the peritoneal cavity.

In operating for localized peritoneal infection, it is of paramount importance that the infection remains localized _ and is not made a diffused septic peritonitis through the manipulations connected with the operation undertaken for its relief. While this conversion of a localized into a diffused septic peritonitis is sometimes unavoidable (the mere act of opening up the parts being sufficient to cause it), yet, unquestionably, it is sometimes the result of avoidable causes or acts.

In the main, the difference in operating for localized and for diffused septic peritonitis, is one of scale rather than kind _ the essential features and principles are the same in both.

A typical illustration of localized septic peritonitis is often encountered in cases of acute appendicitis _ and as the technic of meeting that condition will be described there _ and as the general principles of treating diffuse septic peritonitis will be given immediately following _ no separate description will be here given of the technical details of the operation for localized infective peritonitis.

OPERATIVE TREATMENT OF DIFFUSE SEPTIC PERITONITIS

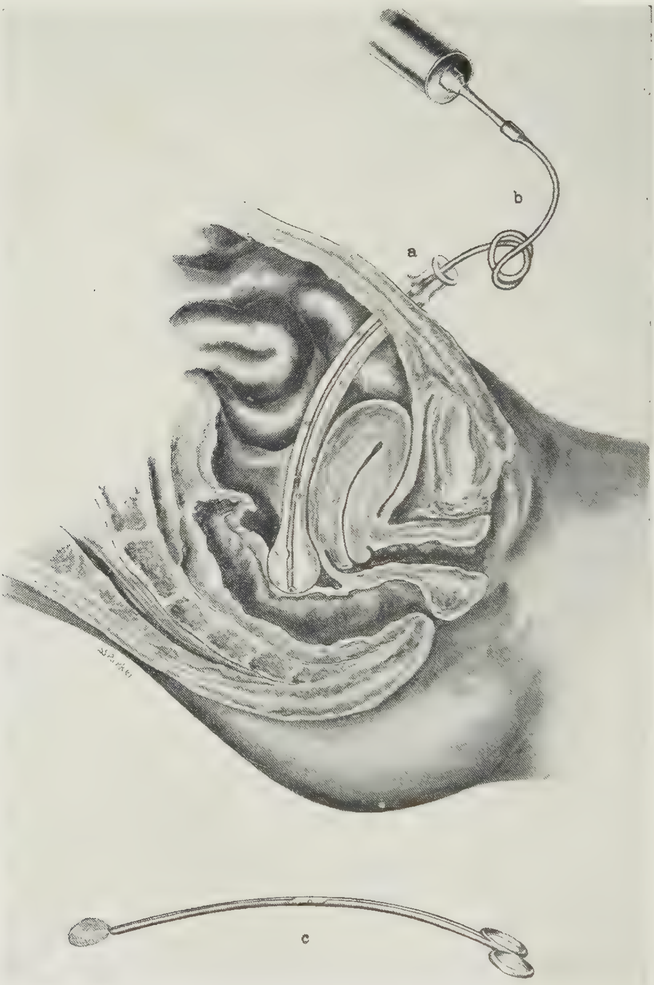
A number of varieties, or combinations of methods of operating for diffuse septic peritonitis, have been resorted to by different Surgeons _ methods not representing any radically new ideas, but various groupings of technics independently employed. While presenting nothing new in the individual steps, some of these groupings have been systematized by different Surgeons, with whose names they have become associated.

Some of these methods are such as the following: _ Dry sponging, with or without suction evacuation of infected fluid, followed by closure with drainage; _ Spontaneous evacuation of septic fluid through the wound of exposure, with minimum handling of the structures, without irrigation or sponging, and with the establishment of drainage, followed by the semisitting posture, and by the intermittent rectal administration of saline solution (the Murphy technic); _ Free saline irrigation of the general peritoneal cavity, followed by closure without drainage, except in the presence of necrotic tissue (the Blake technic); _ and the like.

The adoption or omission of irrigation, and the adoption or omission of drainage, constitute the two more important features of technic in which are ranges of differences of view, _ such as local, general, or no irrigation _ simple drainage, or simple drainage with added counterdrainage. When drains are used, they may be of the cigarette, cigar, or Mikulicz type _ rubber tubing, plain, split, or perforated, with or without gauze _ plain gauze _ glass tubing plain, or perforated, with or without gauze. The drains may come through unsutured wounds, or through wounds partly sutured. Drainage may be simple (through the wound of entrance) _ or may be augmented by counterdrainage, such as through openings in the pelvis, loin, perineum, vagina, or suprapubically. The posture of the patient, following operation, may be horizontal _ may be by elevation of the upper part of the body, so as to direct infected fluids away from the diaphragm and toward the pelvis _ or may be such as to direct the outflow of infected fluid toward some counteropening for drainage.

Several of the more commonly employed operative methods of treating diffuse septic peritonitis will be here considered (following which, under Comments, will be given some observations common to the operations in general): _

Operative Treatment of Diffuse Septic Peritonitis, Followed by Dry Sponging, With or Without Suction Evacuation of Infected Fluid, and Closure, with the Establishment of Drainage.—The peritoneal cavity is exposed by the usual method of abdominal section. In approaching the peritoneum, more than usual care is exercised, for the recognition of attachments of the intestines to the peritoneum, and to each other. As soon as the peritoneum is incised, a gush of septic peritoneal fluid may flood the wound _ and part of the intestinal tract, as well, may be forced out under pressure. The best method of both absorbing fluid and controlling the intestines is by means of soft, lintless towels, wrung out of warm saline solution, and taped, clamped, and counted. The margins of the abdominal wound are at once parted by retractors _ and also slightly elevated, if there be a tendency to evisceration, _ while the towels are so placed as to accomplish a threefold purpose _ absorption of fluid _ restraint of intestines within the cavity _ and the walling off of the viscera so that access is made easier to the source of infection. It is manifestly plain that, apart from freeing the cavity of the septic fluid already present, the recognition of the source of infection is of primary importance—as such recognition offers the only chance of controlling the focus of the originating trouble. The first object of the operation, therefore, after the reasonable control of the septic fluid, is to discover and repair the causative defect. If, for instance, a ruptured appendix, or pus-tube, have caused it, the technical procedure for the repair, or elimination, of these structures is carried out. The final stage of the operation is the toilette of the peritoneum. The contents of the abdominal cavity should be handled as little as possible consistent with thoroughness. If septic fluid be present in such quantity as to collect in the lowest recesses, apart from having overflowed the wound margins, on opening the abdomen, such excess is best removed by suction drainage—for



Figs. 3423 and 3424.—Abdominopelvic Drainage by Means of a Perforated Glass Drain:—**a**, Perforated, curved glass tube, with bulbous distal enlargement and knobbed proximal end;—**b**, rubber tube and syringe, by means of which collected fluids are periodically removed by suction from the cavity of the tube, into which they have seeped; **c**, special long, slender dressing-forceps, carrying a mop of gauze—as an alternative means of removing fluid collected within the tube.

in this manner there is less dissemination of the fluid, and less traumatism to the serous-covered structures than by any other method of evacuating it – and while this may seem an unnecessary refinement in cases where all the intra-abdominal structures have been practically bathed in the fluid, yet its removal in this way is less harsh than through some of the methods of evisceration for the purpose of cleansing the cavity, or the usage of towels for wholesale absorption. When there is an excess of the fluid, and the bulk of it has been removed by suction, the residue is then best removed by light sponging with dry gauze mops, used in mopping fashion – not by harsh rubbing of the parts. The cavity should be left as dry as reasonably possible. In employing suction drainage, the perforated outer cylinder of the abdominal tube allows the fluid to seep through into contact with the exhausting tip of the inner cylinder, so that when suction is applied, the walls of the intestine are not drawn against the perforations of the exhausting tube, thereby blocking the drain (as well as damaging the intestine). In the absence of a technical suction-drainage outfit, a closed bulbous tube, perforated (such as often used for permanent drainage), may be carried to the lowest part containing the septic fluid to be exhausted – and then, through this, an ordinary catheter, attached to an ordinary suction syringe may be lowered to the bottom – and with it, the fluid be sucked up, discharging the syringeful, at the end of each action (Figs. 3423, 3424, **a** and **b**), – or a small gauze mop, held in delicate forceps, may be carried down to the bottom of the bulbous tube, and be repeatedly introduced, withdrawn, squeezed dry, and reintroduced (Fig. 3424, **c**). Of course these substitutes are slower methods than the accomplishment of the same ends by the technical suction-drain outfit.

Finally, the question of drainage comes up for disposal. Unquestionably, drainage is often successfully omitted, both in some cases of limited localized infection – and in some cases of diffused infection – but there is no doubt that some form of temporary drainage is indicated, and constitutes a safer and more conservative surgical technic, in intra-abdominal cases where a condition of actual sepsis exists. In cases of diffused intraperitoneal sepsis this is accomplished in a variety of ways. The most frequently employed method is, probably, the introduction of a large composite cigar-drain of gauze and rubber tissue, introduced low down in the median line – such a drain, for example, is shown in Fig. 3425, where it is applied in the region of the appendix, for a localized condition – and as it may be applied in the median line, in the instance of general suppurative peritonitis. In this latter instance, a long, large cigar-drain is being carried to the bottom of the pelvic cavity by means of long, curved dressing-forceps (Fig. 3426). Lateral drainage, as well as drainage through the loin – either as the sole drainage – or as counterdrains to the main median abdominal drain – may also be employed. In Fig. 3425 lateral drainage by means of a Mikulicz bag and pack is shown – in which a square of double gauze is carried into the wound, and into this strips of gauze are packed. In the same figure is shown a vaginal drain, passing through the dome of Douglas' culdesac, into the peritoneal cavity. Another form of gauze-bag drain sometimes employed (and it may also be applied to the Mikulicz bag) is such a one as shown in Fig. 3427 – which is tied at its end, and inverted, the ligature ends coming out of the center of the bag, as it rests in the wound. This is packed with strips of gauze, as is Mikulicz's gauze bag. Before the bag is to be permanently removed, the strips alone are taken out and replaced by fresh ones – and when the drainage is no longer indicated, and time has been given for the walls of the bag to somewhat loosen themselves from the adjacent peritoneal walls, the bag is removed by traction upon the ligature ends – which withdraws the bottom first.

The wounds through which drains are placed are, at the end of the operation, ordinarily closed by suture in part – guarding against too tight constriction of the drain. It is often of practical usefulness, in planning temporary drainage, and prior to inserting the drain, to place the sutures (of non-absorbable material) through the lips of the wound, loosely knotting them – and then place the drain between the parted sutures. In this way, when the drain is abandoned, in those exceptional cases where it is then desired to suture the granulating wound, the already placed sutures have simply to be tied. (Provision for even absorbable sutures of some of the layers could be made by the introduc-

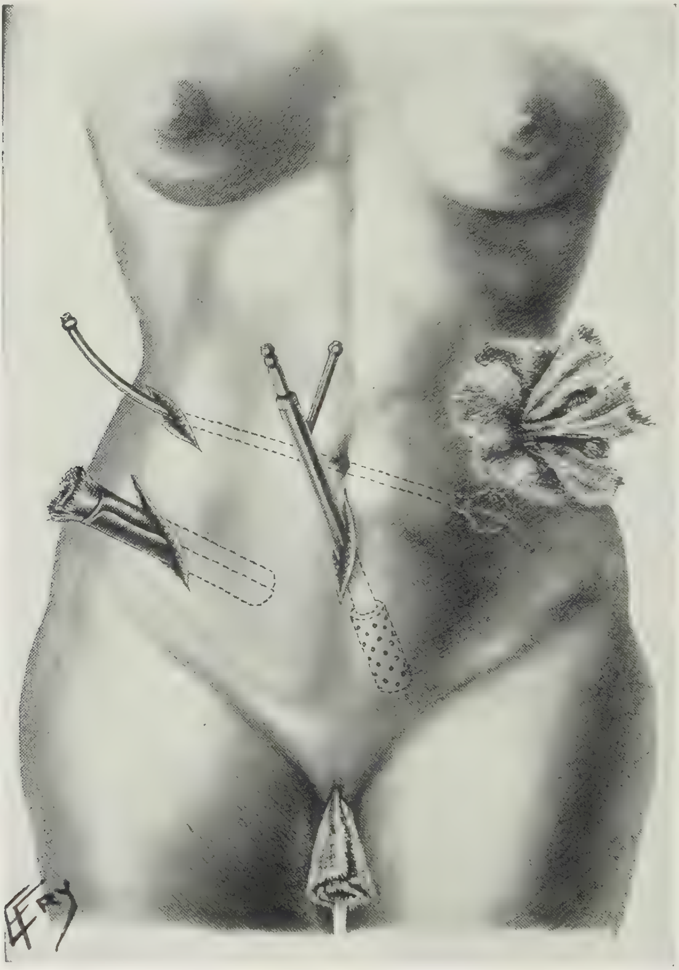


Fig. 3425.—Sites and Forms of Intra-abdominal Drainage and Irrigation: – (1) Cigarette drainage in the appendical region; (2) Mikulicz bag and pack in the left hypochondriac region; (3) gauze drain from the pelvic peritoneum through the posterior vaginal pouch and vagina; (4) intraperitoneal irrigation by Blake's irrigator through median incision (the filling funnel and exit tube are not attached); (5) drainage of the pelvic peritoneum may also be accomplished through this wound, especially if made somewhat lower; (6) intraperitoneal irrigation by Kelly's irrigator (the water returning through open wound, along tube, after distending abdomen); (7) drainage of the right hypochondrium may also be secured through this wound.

tion of silk suture-carriers instead of the actual sutures.) Practically, however, such wounds are rarely sutured _ the wound left by the final withdrawal of drainage, quickly closing of its own accord _ and, in the meantime, being kept slightly patulous for safety, by means of light packing.

(*b*) **Operative Treatment of Diffuse Septic Peritonitis, Followed by Spontaneous Evacuation of Septic Fluid Through the Wound of Exposure, with Minimum Handling of the Structures, Without Irrigation or Sponging, and With the Establishment of Drainage _ Followed by the Semisitting Posture, and by the Intermittent Rectal Administration of Saline Solution** _ The Murphy Technic.—The features of this method are as follows:

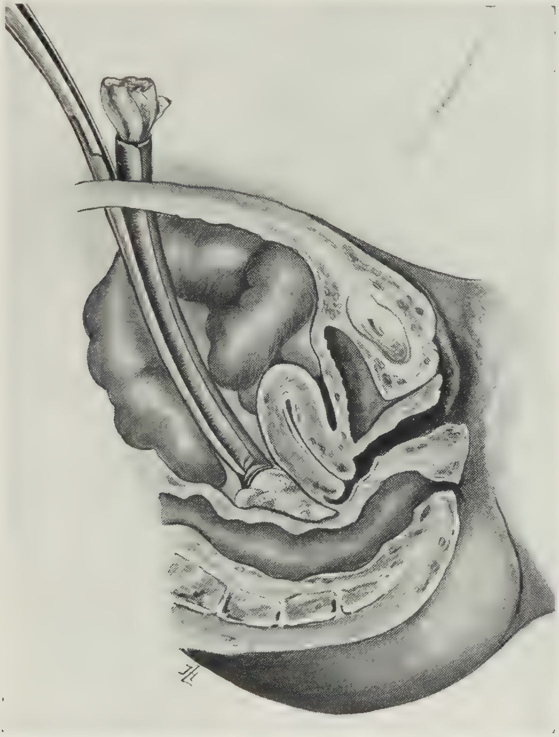


Fig. 3426.—Intra-abdominal Cigar Drain of Rubber Tissue and Gauze _ being introduced by long, curved dressing-forceps, through the abdominal wound, to the pelvic floor.

(1) The rapid removal of the cause of infection, as far as possible, and with the minimum handling of the intestines. No attempt is made to sponge the peritoneal surfaces, or to remove lymph exudate, which would tend to open up channels for toxic absorption.

(2) The drainage of the bottom of the pelvis through a suprapubic incision, as well, if necessary, as through the operative incision. The combined postoperative posture and the action of the diaphragm thereby aid in the expulsion of accumulated fluid.

(3) The foregoing of all lengthy procedure and secondary objects accomplishing satisfactory drainage and minimizing manipulation and length of anesthesia.

(4) The semisitting postoperative posture (Fowler's position), _ for the

purpose of causing the fluids to gravitate toward the drains and away from the channels of greatest absorption into the system.

(5) The postoperative absorption of large quantities of warm saline solution through the rectum, thus reversing the lymphatic current and converting the peritoneal surface into a secreting rather than an absorbing membrane – and also largely increasing the urine. This is accomplished in the following way: – a nozzle with several openings is inserted into the rectum – to which is attached a rubber tubing leading to a reservoir bag – the bag hanging only a few inches above the level of the rectum – so that the fluid simply trickles into the rectum at but slightly faster rate than absorption occurs. From 1 to 2 pints flow in continuously in about an hour (up to 18 pints in twenty-four hours). Through the extra holes in the nozzle flatus is expelled and the intestine thus kept deflated, especially as the nozzle may remain *in situ* after the tube is disconnected. The peritoneum thus discharges fluid freely – which, by diaphragmatic action and the special posture, is carried downward toward the dependent drains – thereby washing the peritoneum in its passage over its surface and escaping through the exits provided. The heart's action is increased and larger quantities of urine are voided, thus increasing the elimination of septic material.

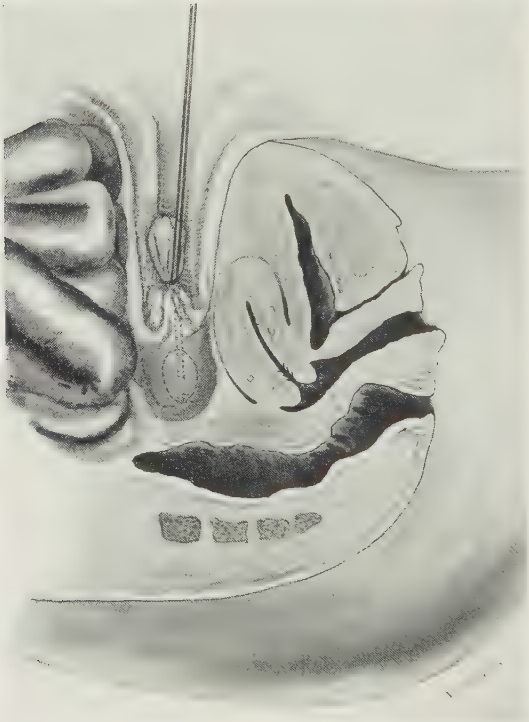


Fig. 3427.—Intra-abdominal Mikulicz Bag Drainage – Withdrawal of the drainage-bag at the end of its service; – method of loosening and withdrawal of the bag by traction upon the knotted end of the ligature – after all strips of the packing have been separately removed from the interior of the sac.

(6) Intestinal peristalsis is prevented by abstinence from mouth-feeding and drinking – thereby lessening the chance of disseminating septic matter. Opium may possibly be given to aid to this end.

(*c*) **Operative Treatment of Diffuse Septic Peritonitis, Followed by Free Saline Irrigation of the General Peritoneal Cavity, With Closure Without Drainage (Except in the Presence of Necrotic Tissue) _ The** Blake Technic.—The features of this technic are, in the words of its author, _ "Early operation _ lavage of the peritoneum with large quantities of saline solution _ closure of the peritoneal cavity without drainage, unless the latter is absolutely indicated by the presence of non-absorbable amounts of necrotic material."

Three categories of cases are recognized _ Localized collections of pus, with limiting adhesions _ cases of spreading peritonitis with no limitations of the process by adhesions or gravitation, but in which the limits, nevertheless, are ascertainable _ and cases of general peritonitis in which apparently the entire peritoneal cavity, with possibly the exception of the lesser cavity, is involved. The last two categories constitute general diffuse peritonitis.

The two essential features of the technic are: _ The removal, as early as possible, of the cause of infection, or the limitation of the results of infection, thereby minimizing additional peritoneal and general infection; the placing of the peritoneum in the best condition to combat and eliminate generalized infection.

The peritoneum is cleansed by abundant irrigation with decinormal saline solution of 110° F. This solution may be delivered into the cavity of the peritoneum from the mouth of a pitcher _ or is carried throughout the indicated portions of the peritoneal cavity by means of a special irrigator (Fig. 3425). As much of the fluid as does not readily flow out is left in the cavity _ and handling of the intestines, other than done by the irrigator and fluid, is avoided. The peritoneal endothelium is thus less damaged and the detachable products of infection are diluted and removed.

In those cases in which the focal cause of infection can be removed, drainage may or may not be used. In other cases drainage has been generally used by the majority of operators. The author of the technic later omitted drainage almost entirely _ only using it in cases where the existence of necrotic tissue or hemorrhage necessitated it.

When indicated, the parietal wound can be drained down to the peritoneum. Other forms of intra-abdominal irrigation and drainage are shown in Figs. 3423–3426.

Comments.—Two of the main objects of the operative treatment of septic peritonitis are, the lowering of the mechanical tension which favors absorption, and the provision of a free channel for the escape, by drainage, of infective material from the peritoneal cavity.

The towels introduced to absorb peritoneal fluid should be soft, absorbent, and as nearly lintless as possible. All means should be used not to scrape, scrub, rub, or otherwise damage the delicate serous coverings by de-epithelization, through which increased absorption would occur, and additional adhesions result.

All surfaces made raw by the steps of the operation should be protected from absorption as far as it is possible. Differences exist in the degree of infectivity of the septic fluid in infective peritonitis, dependent upon many circumstances.

The unnecessary breaking up of planes of adhesions supplies fertile ground for additional absorption. While adhesions which block the escape of pus must be broken down _ the breaking down of adhesions which it is not absolutely necessary to sever will only result in greater absorption and firmer re-adhesions.

Burghard states, _ "Under all circumstances, general flushing of the peritoneal cavity is to be avoided, as likely to enlarge the area of infection, and to favor the absorption of both bacteria and toxins. Evisceration for the purpose of cleansing the intestines and peritoneal cavity is still more strongly to be deprecated."

Generally speaking, when suppuration is already present, drainage is indicated _ but when early infection alone is present, especially if limited and of minor grade, closure without drainage can often be carried out _ leaving the care of the infection to the peritoneum _ and provided the original source of infection has been controlled. Each of these cases is a matter for individual judgment.

Ordinarily a single drain suffices _ but in the presence of adhesions, or where additional collections of pus are likely, especially if unfavorably situated, a secondary counterdrain may be indicated.

It is to be remembered that an intraperitoneal drain is practically walled off within twenty-four hours, and, from that time on, largely ceases to act as an active drain of any region other than its immediate tract.

General anesthesia is preferable, as a rule _ and ether is the best agent, used by the drop-method, or closed cone. An infra-umbilical, median incision is the best method of approach, unless a special incision be indicated.

There is much to recommend a relatively short incision _ where no other manipulation other than that of drainage is to be considered. This is because these wounds are usually used for drain-exits _ and are frequently the sites of postoperative hernia _ and if a long wound be sutured, the sutures frequently fail to hold, if the wound be involved in the infection, which is so often the case. Therefore, an original small wound (small enough not to require suturing) is less apt to allow the bowel to prolapse during operation _ and, after operation, lends itself better to the problem of drainage in an infected site. Where, on the other hand, the wound must also serve to furnish ingress to, and correction of the focus of originating trouble (as, unfortunately, is usually the case) then the wound of entrance must be made large enough to accomplish the object of greatest primary importance _ which is the arrest of the cause of the infection.

The cases in which general intraperitoneal irrigation seems most warrantable are those in which the septic fluid of a universal peritonitis is filled with the products of some gross soiling _ such as the contents of a wounded stomach, intestine, bladder, and the like _ for it must be evident that it is better to have the abdominal cavity overflowing with clean, warm saline solution, than with a mixture of pus and feces _ and that even a dilute solution of these (such as occurs from the addition of the irrigant) is better than a concentrated solution of them _ and if they have gotten literally everywhere over the cavity before the irrigation is used, they cannot get any further through its being used.

After a drain has ceased to drain _ which, it seems to be universally admitted, is measured by a comparatively few hours _ the peritoneum must take care of the infection largely, or entirely, as though it were not drained at all.

Large intra-abdominal drains, like the Mikulicz pack, are to be condemned _ accomplishing no more than a cigar-drain of reasonable size _ and doing more intestinal damage by causing the matting together of innumerable coils.

Some Surgeons remove the drain as soon as the exudate becomes serous _ maintaining it as long as it is purulent.

Murphy taught that drainage from the peritoneal cavity continued even after the drain has been *in situ* more than twenty-four hours, in cases of infective peritonitis.

Rigid tubes of glass and of rubber, as drains, have been largely replaced by various combinations of soft-rubber tissue and gauze (v. Vol. I, p. 23).

When irrigation is employed, warm normal saline solution is generally poured into the peritoneal cavity from a pitcher, upon the coils of intestine — or, better, may be caused to flow outward from the bottom of the peritonea cavity, by the use of such an outfit as Blake's intra-abdominal irrigator.

Owing to the difficulty of removing a simple gauze drain — and its inability to satisfactorily take care of any but the most fluid exudate — it should not be used alone — but should be surrounded by rubber tissue, with or without perforations, or be paralleled by another drain.

As evisceration adds to shock, care should be exercised to prevent the escape of intestinal coils from the abdomen.

Following operation with drainage, patients are usually placed in the position which tends to cause a flow of the fluid to be drained, toward the immediate vicinity of the drain. That is, where there is drainage of the lower aspect of the abdomen, the patient is put to bed with his head and shoulders elevated (Fowler's position) — even additionally elevating the upper end of the bed. If the drainage be of the upper aspect of the abdomen, the decubitus is usually horizontal — with the patient generally tilted toward the drain, to one side or the other.

The postoperative use of normal saline solutions is often indicated — and the technical details of these procedures have been already given; — Intravenous Infusion, Vol. II, p. 186, — Hypodermoclysis, Vol. I, p. 299, — Proctoclysis, Vol. I, p. 295.

There are cases in which the cause of a septic peritonitis cannot be discovered — or, if discovered, cannot be remedied — and, in these cases the septic peritonitis must be largely treated as an entity.

The semisitting posture of Fowler, with the thighs flexed, accomplishes all that can be done, by position, to direct septic fluids toward the region of the drain — in infections of the lower half of the abdomen

It is to be borne in mind that general peritonitis is often rather loosely and inaccurately used — as the process is very exceptionally absolutely universal. Certainly, the earlier well-declared, progressive cases are operated upon, the more localized will be the process — with a correspondingly brighter outlook.

OPERATION FOR INTRAPERITONEAL ABSCESS

Of the three forms of intraperitoneal abscess which may present themselves, visceral abscesses (those occurring entirely within organs, or their walls) and visceral abscesses surrounded by an encapsulating peritonitis are not included — as they more properly come under the operative surgery of the special organs involved.

The intraperitoneal abscesses here considered are those whose walls are made up of peritoneum or peritoneal exudate.

Where one of the walls of the abscess is formed of parietal peritoneum, and where the size of the process is such as to make the procedure possible and desirable, an attempt should be made to evacuate and drain the pus-cavity without the invasion of the free portion of the peritoneal cavity. The principle of accomplishing this is to incise through the abdominal or abdominopelvic wall immediately opposite the abscess — and then to incise through the parietal peritoneum, which forms the last barrier before encountering the pus. This represents the most fortuitous happening that one may hope to encounter — for in this way the cavity is drained outward — and, practically, extraperitoneally (as far as the free peritoneun is concerned), though, strictly, an intraperitoneal process. The great difficulty in such cases is one of diagnosis, rather than operative — for one must be fairly certain of the data before undertaking to cut through the abdominal wall in some unusual site, upon uncertainty of the conditions (where the position of the cut might be awkward, except for drainage).

It will sometimes happen that the abdomen has been opened in the usual manner _ and that a localized, walled-off abscess will be discovered. If the situation of the abscess be such as to make it possible, it is often better surgery to make a secondary opening down to and into the abscess through an extraperitoneal route. Such a condition of affairs is shown in Fig. 3428 _ where an intraperitoneal abscess has been discovered during an abdominal section through the right semilunar line _ and the abscess is then opened and drained through a small secondary incision made near the crural arch, followed by working up under and through the parietal peritoneum into the pus cavity, guided by the hand within the free cavity _ the cross-section of the condition being shown in Fig. 3428.

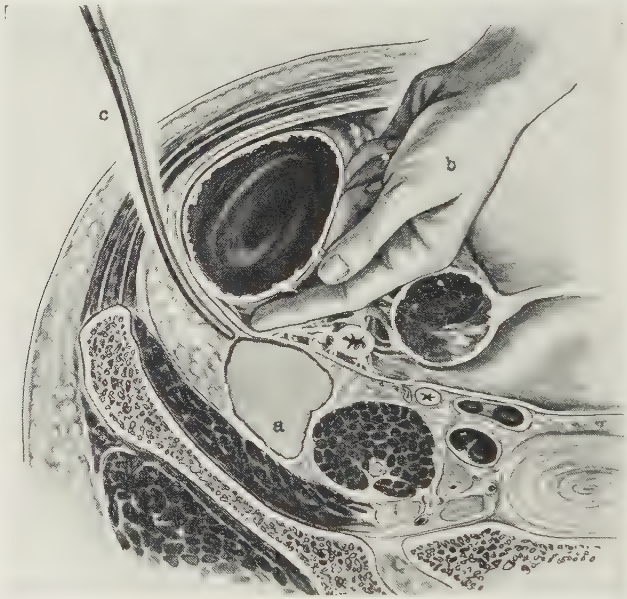


Fig. 3428.—Sectional View of the Extraperitoneal Evacuation and Drainage of an Abscess of Intraperitoneal Origin: _ **a**, Abscess, lying behind the peritoneum; _ **c**, long, curved forceps, conducted through an abdominolumbar incision, in the abdomino-lumbo-pelvic connective-tissue plane, from the outer wound to the abscess, guided by the finger, **b**, within the abdominal cavity, which discovered the extraperitoneal pus-focus during an intra-abdominal operation. (Figs. 3428 and 3429 modified from Kelly and Hurdon.)

It happens, however, very frequently the abscess is first definitely located only after opening the abdomen _ and that it can only be opened and drained directly through the part of the peritoneal cavity which is free and uninvolved _ that is, transperitoneally. In such cases the peritoneal cavity in the neighborhood of the abscess is protected by gauze-pads _ made to circumscribe the area as well as possible, from the protective standpoint, against soiling _ and also serve to wall-back interfering coils of intestine and of viscera. The abscess is then incised (or it may be first partly emptied by aspiration, to diminish the tension) _ or opened by blunt dissection _ the pus caught upon the protective pads as well as possible _ and drainage, usually by a cigar-drain, provided, from the focus of pus to the wound of exit. The technic of transperitoneal drainage is shown in Fig. 3429. The drain-channel forms the route of least resistance for the pus _ and it is remarkable to what extent the pressure of the coils of intestine, and general intra-abdominal pressure, will often tend to drive the pus outward along this course _ and prevents its general dissemination throughout the peritoneal cavity and among its structures.

More latterly there has been, in some quarters, a tendency to even be less careful in the preliminary packing-off of the area with gauze, before opening the abscess _ depending upon the pus to follow out along the Surgeon's fingers, through an incision of the pus-cavity which is at first limited, and afterward enlarged. While abscess walls are often purposely broken down for their removal, it seems unnecessary to discard the partial protection of the neighborhood which gauze-packing affords, when it is available.

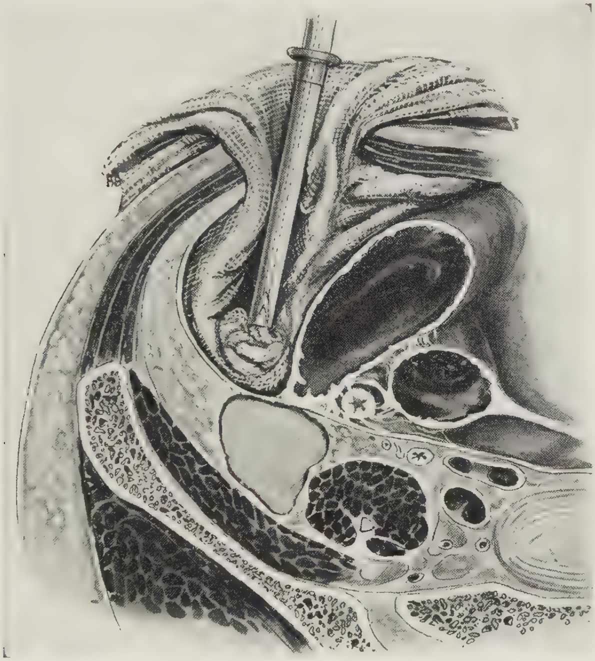


Fig. 3429.—Transperitoneal Evacuation and Drainage of an Intraperitoneal Abscess; _ Followed, here, by the displacement of the cecum inward, and the protection of the neighborhood with gauze. Such protection with Mikulicz pack is here illustrated _ but is shown as though in position after the abscess had been evacuated _ although the barrier packing will have preceded the opening of the abscess.

The adoption of cigar- and cigarette-drains is preferable to the bulky gauze-packs of the Mikulicz type _ nor is there any good, but rather harm, that the method of drainage should occupy an unnecessarily large part of the peritoneal cavity.

It is to be remembered _ and much that has been said of the operative treatment of septic peritonitis also applies here _ that drains, in the case of transperitoneal drainage are but short-lived in usefulness _ and that they may soon become plugs, preventing drainage, rather than drains, inviting it

Perforated, or split rubber tubing, with or without a core of gauze, or folded rubber-dam, or the cigar-drain, are the types most frequently employed in intraperitoneal drainage.

Nor is there as great tendency now as formerly to keep the abscess cavity distended with packing to its very bottom for as long a period as formerly. It is now commoner to find the drain sooner removed from the depth of the sinus _ substituting, as soon as seems wise, this full-depth drain, by one which simply passes through the thickness of the abdominal wall and merely enters the peritoneal cavity.

A practical way in which the writer has practised control over the depth of an intraperitoneal drainage-tract, in case of need of subsequently utilizing it, when time is reached to begin the withdrawal of drainage methods _ is the placing of a piece of rubber tubing in the wound of exit, which is just long enough to enter the peritoneal cavity _ and then pass down through this the smallest size rubber catheter, anchoring its end to the rubber-collar which holds open the wound in the abdominal wall (utilizing the velvet-tipped end of the catheter).

Another good way of withdrawing drainage is to shorten the tube every two or three days _ as well as to diminish its caliber.

The drainage-tube channel is, practically, an extraperitoneal tract _ as soon as adhesions have formed around it.

Some Surgeons, after the first removal of the original drain, at the end of three or four (to five or six) days, do not even carry a light packing to the bottom of the sinus _ but merely keep the abdominal wound patulous. And some Operators irrigate the sinus with normal saline at the time of the dressings _ and some do not. The first change of outer dressing, on the day following operation, is usually found saturated with discharge _ which then rapidly grows less.

Adjacent abscess will often spontaneously discharge into the principal drainage tract.

Intraperitoneal abscesses are best opened by carefully pushing the closed blades of a pair of dressing-forceps into the abscess, and then opening the blades.

CHAPTER LXV

OPERATIONS UPON THE OMENTUM AND MESENTERY

Surgical Anatomy of the Omentum, p. 219.

Omental Grafting, p. 219; _ Operation for the ligation and excision of the omentum, partial or complete surgical anatomy of the mesentery, p. 220.

Anatomy of the mesentery, p. 222; General surgical considerations in operating upon the mesentery, p. 223; _ Partial excision of the mesentery, p. 223; _ Suturing of the mesentery, p. 223.

SURGICAL ANATOMY OF THE OMENTUM

Description.—The omenta are folds of peritoneum connecting the stomach with other viscera. They consist of the great or gastrocolic, small or gastrohepatic, and gastrosplenic omenta.

Great or Gastrocolic Omentum.—Passes down from the greater curvature of the stomach as an apron in front of the small intestine, thence upward to be fused with the transverse colon, being connected with the gastrosplenic omentum on the left, and with the hepatic flexure of the colon and descending colon on the right; _ consisting of four layers, two descending and two ascending; the two middle layers belonging to the lesser sac and the two superficial layers to the greater sac; _ its vessels coming chiefly from the gastro-epiploica sinistra of the splenic artery, and to a less extent from the gastro-epiploica dextra of the gastroduodenal branch of the hepatic artery.

Small or Gastrohepatic Omentum.—Extends from transverse fissure of liver to lesser curvature of stomach, being continuous on the right with the first part of the duodenum (there forming the ligamentum hepatoduodenale), and, on the left, with the gastrosplenic omentum; _ formed of two layers, one from the lesser and one from the greater sac; _ and having the following relation of vessels between the layers of the hepatoduodenal portion of the gastrohepatic omentum: ductus communis choledochus, on the right: hepatic artery, on the left: vena portæ between the two and somewhat posterior to them.

Gastrosplenic Omentum.—Extends from the fundus of the stomach to the gastric surface of the spleen; _ and transmits the vasa brevia of the splenic artery to the stomach.

OMENTAL GRAFTING

Description.—Consists in the using of isolated pieces of omentum to repair peritoneal defects. These pieces of omentum are excised from the great omentum and sutured to wounded or denuded surfaces, or suture-lines, of the abdominopelvic viscera normally covered by peritoneum. They are especially used to reinforce suspicious intestinal sites _ but may be applied to any of the serous surfaces of other viscera. They become adherent within a few hours _ and thus strengthen weakened sites.

Operation.—The application of omental grafts is called for during the course of intra-abdominal operations _ and the technic of the operation is simple. A small piece of the great omentum, preferably its free aspect, calculated in shape and size to cover the defect by a good margin, is cut away with scissors, distally to previously placed ligatures of gut – and this graft is placed in contact with the area to be reinforced, preceded or not by slight scarification of the site with a needle-point – and is held in contact by means of a few loosely applied, interrupted, fine gut sutures. If the grafts cannot be used immediately after being cut, they are placed in warm normal salt solution until required, when they are partially dried between gauze. The grafts used to reinforce circular enterorrhaphy generally average from 4 to 5 cm. (1½–2 inches) in width, and should be long enough to completely surround the site in question. (See Fig. 3430.)

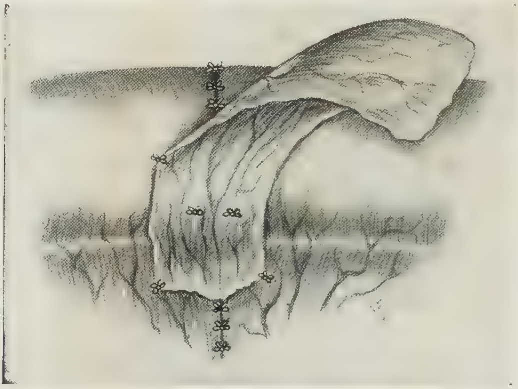


Fig. 3430.—Omental Grafting; – Graft of omentum reinforcing circular enterorrhaphy, sutured to the mesentery and partly sutured to the intestine.

OPERATION FOR THE LIGATION AND EXCISION OF THE OMENTUM, PARTIAL OR COMPLETE

Description.—In the course of intra-abdominal operations, it is often necessary to ligate portions of the omentum, either for the purpose of freeing adhesions, or as a preliminary step to the removal of a part, or even the whole, of the great omentum.

Ligation of Omental Adhesions.—The general principle of dealing with adhesions by separation by blunt dissection, or by ligature and division, described under the operations for peritoneal adhesions (see page 203), applies equally to those of the omentum. Where the separation can be accomplished by blunt dissection, this should be done. Where division by knife or scissors is necessary, this should generally be preceded by ligation with chromic gut. The ligature may be conveniently passed by means of an aneurysm-needle – either around a single band of adhesion, or in sections through broader extents of adhesion (Fig. 3431). The omentum is then divided distally to the ligature or, where indicated, as is generally the case in dense adhesions, between double ligatures.

Ligation of the Omentum Preparatory to Removal of Larger Portions.—The omentum may be so irregularly and completely bound down as to require ligature and division in piecemeal, as in tying off adhesions, in the manner just described. Where, however, it is largely or entirely free, a tier of ligatures may be quickly run across the free portion just above the line of subsequent division. This tier may be applied in sections by means of an aneurysm-needle. Or it may be more quickly placed by holding the ligature in contact with the back or opposite side of the omentum, and then, at proper intervals, piercing the omentum from the front with a pair of catch-forceps, or a Cleveland ligature-carrier, grasping the ligature and drawing it through – it is then cut at each opening through which drawn, interlocked with its neighbor by a half-turn, and tied – as shown in Fig. 3431. Heavy, thick portions of omentum are best crushed with an angiotribe and ligated through the crushed area (Fig. 3432).

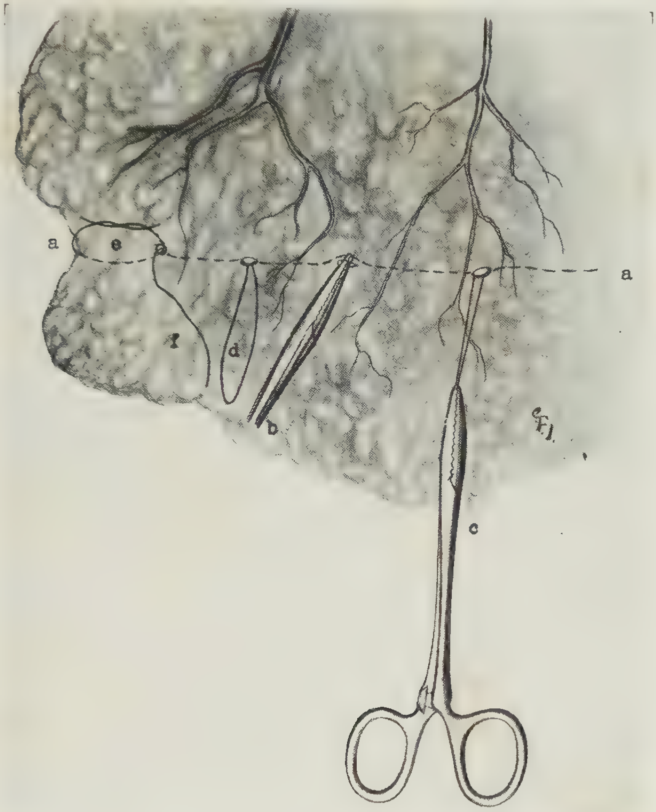


Fig. 3431.—Ligation of Portions of the Omentum, by Interlocking Ligatures, Drawn Through from Behind, Forward, in Loops – Preparatorily to Excision: – **a, a,** A ligature, carried back of the area to be ligated; – **b,** forceps, passed through a punctured opening made in the omentum by its tip, and ready to grasp the ligature and bring it forward; – **c,** a loop brought forward by the forceps; – **d,** a loop ready to be divided; – **e,** a loop about to be tied, one limb of which, from the neighboring loop, is interlocked with a limb of an adjacent loop, **f.**

Comment.—While the whole of the greater omentum has been ligated and excised, this must be rarely called for – and is less desirable, as a surgical procedure, than partial excision.

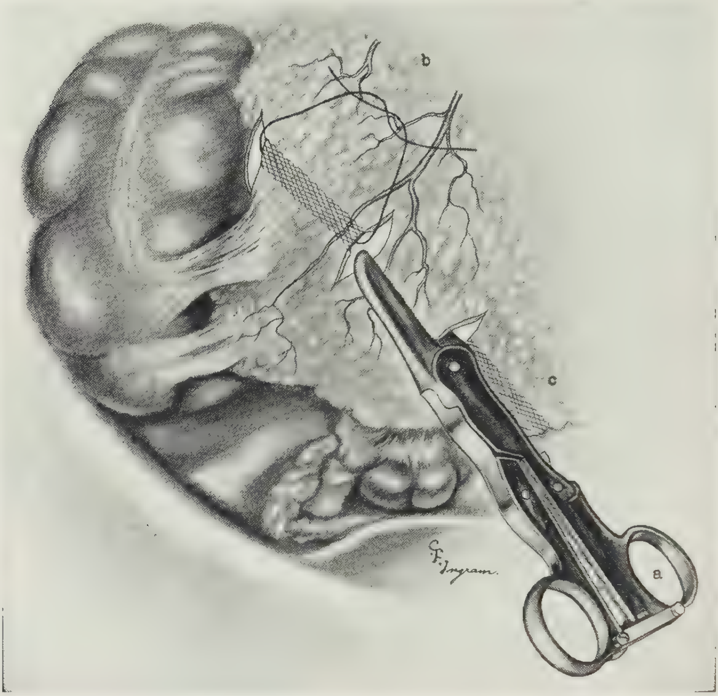


Fig. 3432.—Ligation of the Omentum in Segments, Through Areas Previously Crushed by an Angiotribe, Prior to Excising the Distal Portion:—**c**, A crushed area;—**b**, an area crushed and about to be ligated;—**a**, angiotribe.

SURGICAL ANATOMY OF THE MESENTERY

Description.—The mesenteries are peritoneal folds connecting any portion of the gastro-intestinal tract to the posterior abdominopelvic wall.

Divisions.—Mesogastrium; mesoduodenum; mesentery proper; mesenteriolum (mesentery of the vermiform appendix); ascending mesocolon (sometimes present); transverse mesocolon; descending mesocolon (sometimes present); sigmoid mesocolon; mesorectum.

Mesentery (Proper).—A fan-shaped fold of peritoneum beginning at the spinal column and following and covering the anterior aspect of the superior mesenteric vessels to the loops of the small intestine, enveloping all the coils of the jejunum and ileum (but not those of the duodenum), returning thence along the posterior aspect of the superior mesenteric vessels to the vertebral column. The root of the mesentery extends from the left lateral aspect of the body of the second lumbar vertebra downward, crossing obliquely the spinal column, aorta, vena cava inferior, and third portion of the duodenum, ending at the right sacro-iliac synchondrosis, or in the right iliac fossa. It contains, between its right upper and left lower layers, the mesenteric arteries and veins, lacteals, lymphatics and nerves, all held together by fatty areolar tissue. The right upper layer of the mesentery passes from the root of the mesentery to the lower layer of the transverse mesocolon. Laterally the layers are continuous with the inner lamellæ of the right and left colons. Below, the left layer is continuous with the peritoneum covering the lumbar vertebræ, and passing thence over the pelvic organs. In dimensions, its length (convex intestinal border) is about 6.45 m. (21 feet) _ its width averages 20.5 to 23 cm. (8–9 inches), its greatest width (opposite the central and lower loops of the intestine) being from 20 to 25 cm. (8–10 inches).

GENERAL SURGICAL CONSIDERATIONS IN OPERATIONS UPON THE MESENTERY

The mesentery is involved surgically chiefly in the operation of partial enterectomy.

PARTIAL EXCISION OF THE MESENTERY

See under Partial Enterectomy.

SUTURING OF THE MESENTERY

See under Partial Enterectomy.

CHAPTER LXVI

OPERATIONS UPON THE STOMACH

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SURGICAL ANATOMY OF THE STOMACH

Description.—Lies in epigastric and left hypochondriac regions _ being about five-sixths to left and one-sixth to right of median line; _ lying under the liver and diaphragm, _ above the jejunum, ileum, and transverse colon (also upon the transverse mesocolon, which intervenes between it and pancreas, abdominal vessels, and solar plexus), _ and between gall-bladder on right and spleen on left.

Relations.—Anteriorly and superiorly: diaphragm; thoracic wall (anterior portions seventh, eighth, and ninth ribs); left and quadrate lobes of liver; anterior abdominal wall; lesser omentum. **Posteriorly and inferiorly:** diaphragm; crura of diaphragm; aorta and inferior vena cava; first lumbar vertebra; celiac axis; lesser peritoneal sac; splenic flexure of colon; transverse colon; transverse mesocolon (superior layer); spleen (gastric surface); left kidney and suprarenal capsule; pancreas; splenic vessels; duodenum (fourth, or ascending portion); solar plexus. **Right end:** transverse colon; inferior surface of liver. **Left end:** spleen; diaphragm.

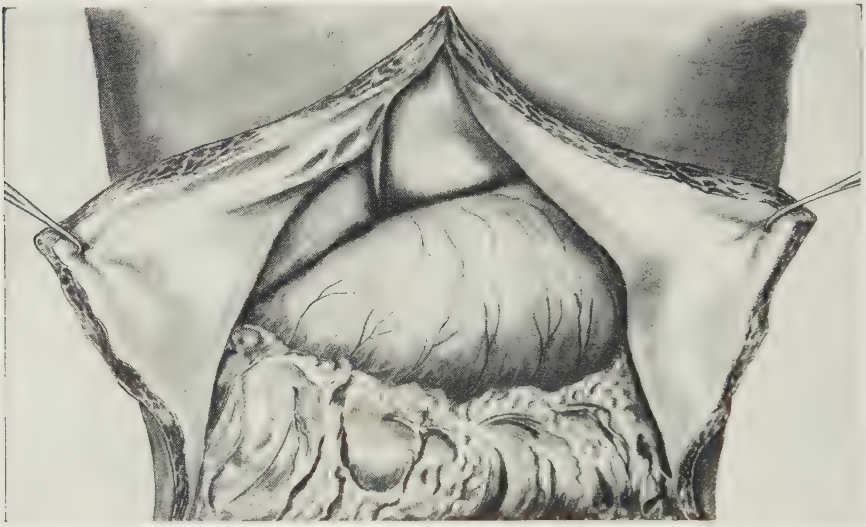


Fig. 3433.—Anterior View of the Stomach _ with the Parts in Normal Position; _ The right and left lobes of the liver _ the round ligament of the liver _ the stomach _ the transverse mesocolon _ and the transverse colon _ are in view, from above downward. (Modified from various Anatomies.)

Position of Cardiac End (Fundus).—Reaches up to the left sixth chondrosternal articulation, or fifth rib in mammary line, and to cupola of diaphragm; _ slightly above and behind the heart apex; _ and 3 to 5 cm. ($1\frac{1}{4}$–2 inches) higher than the cardiac orifice of the stomach.

Position of Cardiac Orifice.—Opposite left seventh chrondrosternal articulation, about 2.5 cm. (1 inch) from sternum; _ also on level with ninth dorsal spine (left side of eleventh dorsal vertebra). Lies from 2 to 3 cm. ($\frac{3}{4}$–$1\frac{1}{4}$ inches) below the esophageal opening, and about 7.5 cm. (3 inches) from the left extremity of the stomach, _ and 11 cm. ($4\frac{1}{4}$ inches) from the anterior abdominal wall.

Position of Pylorus.—On level with bony ends of seventh ribs (which are 5 to 7.5 cm., or 2 to 3 inches, below the sternoxiphoid joint), lying to right of median line and nearer the surface than the cardiac end; _ also on level with twelfth dorsal spine (upper border of first lumbar vertebra).

Fixation Points and Ligaments of Stomach.—Bound to diaphragm by esophagus; _ bound to vertebral column by duodenum; _ ligamentum phrenicogastricum connects cardia to diaphragm; _ gastrohepatic omentum (lesser omentum) connects lesser curvature to liver; _ ligamentum hepatoduodenale connects pylorus and duodenum to liver; – gastrosplenic omentum binds greater end of stomach to spleen; – great omentum binds the stomach only when itself is bound.

Peritoneal Coverings.—Everywhere – except along the upper and lower curvatures, and upon the triangular areas at either end.

Arteries.—Gastric; pyloric and right gastro-epiploic branches of hepatic; left gastro-epiploic and vasa brevia of splenic.

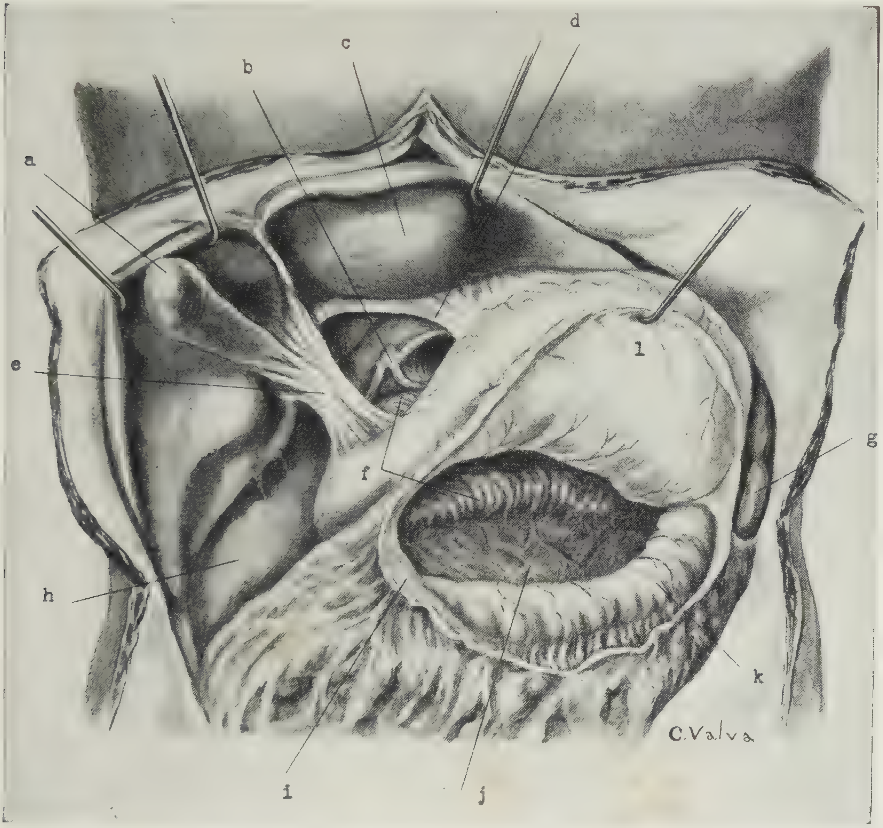


Fig. 3434.—The Stomach, in Relation with Some of the Deeper, Adjacent Structures: – **a,** Gall-bladder; – **b,** celiac axis, with the splenic, gastric, and hepatic arteries in view; – **c,** cleft lobe of the liver; – **d,** incised margin of the gastrohepatic omentum; – **e,** hepatoduodenal ligament; – **f,** pancreas, its upper portion being seen through the incised gastrohepatic omentum – and the lower part, through the incised gastrocolic omentum; – **g,** spleen; – **h,** right kidney, behind the peritoneum; – **i** margin of the incised anterior wall of the gastrocolic omentum; – **j,** posterior wall of the lesser omental cavity; – **k,** transverse colon; – **l,** stomach, so displaced as to expose the supragastric and infragastric incised openings into the lesser omental cavity. (Modified from various Anatomies.)

Veins.—Coronary and pyloric, emptying into portal vein; right gastro-epiploic, emptying into superior mesenteric; left gastro-epiploic, emptying into splenic.

Nerves.—Right vagus (posterior surface); left vagus (anterior surface); solar plexus of sympathetic system.

Lymphatic Glands.—Along greater and lesser curvatures – and at pyloric and cardiac ends.

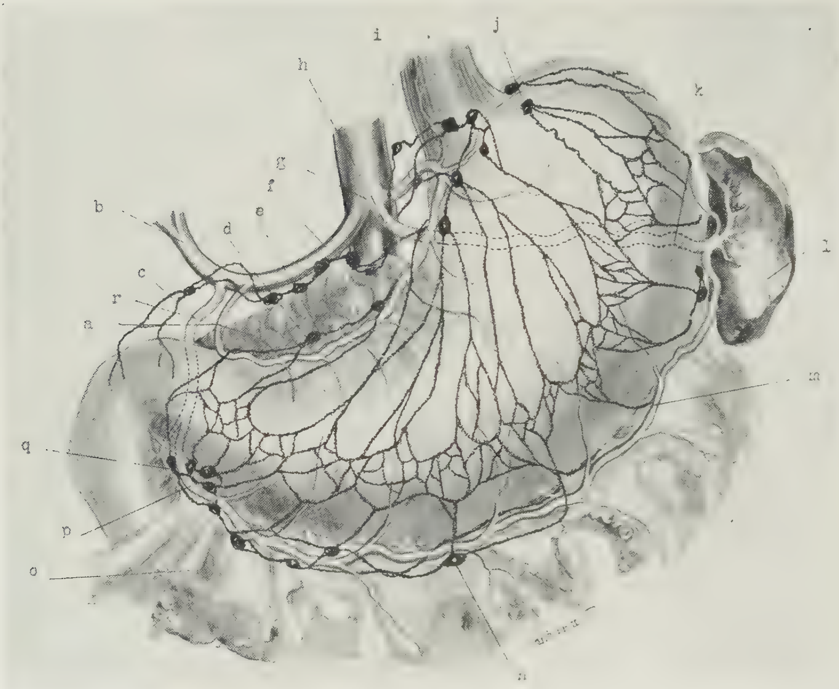


Fig. 3435.—Vascular and Lymphatic Supply of the Stomach:—**a**, Pyloric artery;—**c**, gastroduodenal artery;—**b** and **f**, hepatic artery;—**e** and **i**, coronary artery;—**g**, celiac axis;—**h** and **k**, splenic artery;—**l**, spleen;—**m**, left gastro-epiploic artery;—**o**, great omentum;—**p**, right gastro-epiploic artery;—**q**, suprapancreaticoduodenal artery;—**r**, pancreas;—**d**, superior coronary glands;—**n**, inferior coronary glands;—**j**, paracardial glands. (Modified from various sources.)

SURFACE FORM AND LANDMARKS

The stomach when empty—lies far back in the abdominal cavity, beneath the left lobe of liver and in front of the pancreas.

In moderate distention—cardiac end lies beneath the left seventh chondrosternal articulation, about 2.5 cm. (1 inch) beyond the sternum. Pyloric end lies opposite a point near the end of the eighth right chondrocostal articulation.

Borders (curvatures) of stomach are represented, approximately, by curves of the characteristic contour between the points just given—the greater curvature reaching at first to the left, then downward to the infracostal line. The lesser curvature crosses the vertebral column on a level with the first lumbar vertebra. The greater curvature crosses the epigastrium on a line connecting the ninth and tenth costal cartilages—which is about two fingerbreadths above the umbilicus.

Gastric fossa—a triangular area of about 40 square centimeters ($15\frac{1}{2}$ inches) of the anterior wall of the stomach where it lies in direct contact with the abdominal wall—bounded, below, by the transverse colon; above and to left, by seventh, eighth, and ninth costal cartilages; and above and to right, by the anterior border of the liver.

GENERAL SURGICAL CONSIDERATIONS IN OPERATIONS UPON THE STOMACH

Stomach may be recognized by its relation to the inferior surface of the liver _ by its continuity with the anterior layer of the gastrohepatic omentum _ by its thick and stiff wall, as determined by pinching it up between the fingers _ by the direction of its vessels _ and by its pinkish-white color and absolute opacity. The stomach and transverse colon have been mistaken for each other. The transverse colon should be displaced downward and the liver upward _ revealing the stomach between them. If not otherwise recognizable, follow back the under surface of the liver to the portal fissure, with the index-finger _ thence downward along the gastrohepatic omentum to the stomach.

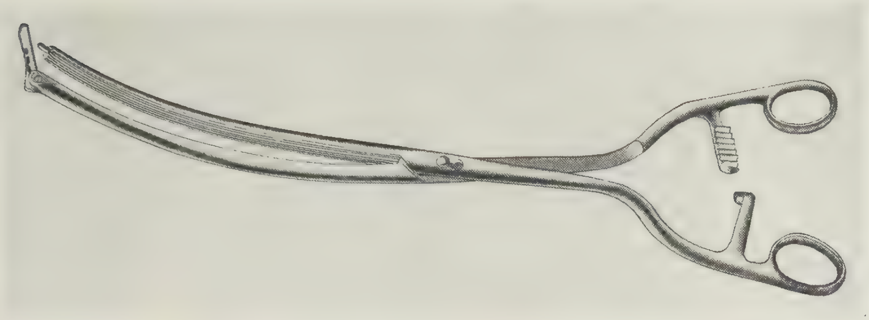


Fig. 3436.—Kocher's Curved Stomach Resection Clamps.

Anterior gastric wall lies in the greater peritoneal cavity _ and its posterior wall in the lesser cavity.

Superior wall of the transverse colon lies in the lesser peritoneal cavity _ and its inferior wall in the greater cavity.

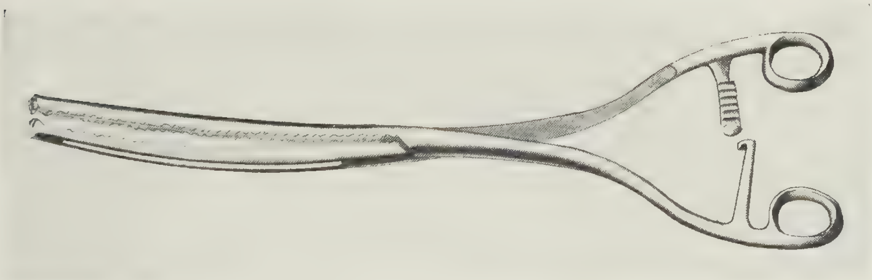


Fig. 3437.—Graser's Stomach Forceps.

Mesentery descends downward and forward from under the back part of the transverse mesocolon. The omentum major descends from the greater curvature of the stomach and inferior aspect of the transverse colon _ and may contain a cavity and be continuous with the omentum minor above the transverse colon _ but its component layers are more generally united. The omentum can be more conveniently displaced upward and to the left.

Preparation of the Patient for Operation.—Especially should preliminary care be given to patients upon whose stomachs operations are about to be performed, owing to the functional activity of the organ, and especially owing to the fact that when the viscus is opened in the course of surgical procedures, conditions approximating outside, non-aseptic ones are encountered. Not only does careful preparation of the gastro-intestinal tract play a large rôle upon the operation as a local measure, but often a great deal of the patient's postoperative discomfort might be avoided through careful preliminary prep-

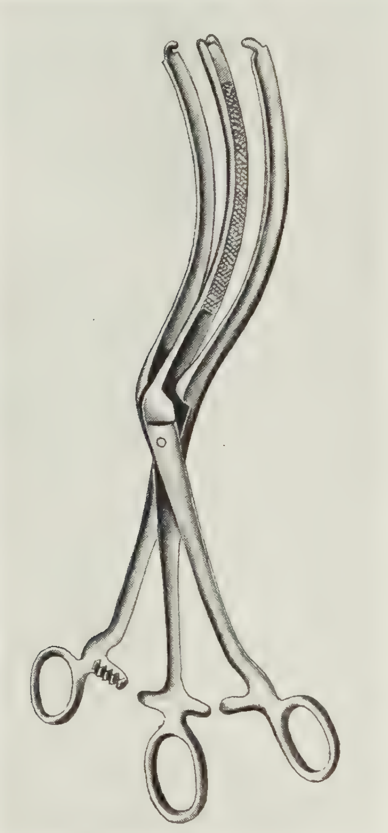


Fig. 3438.—Linnartz's Three-blade Gastro-intestinal Forceps.

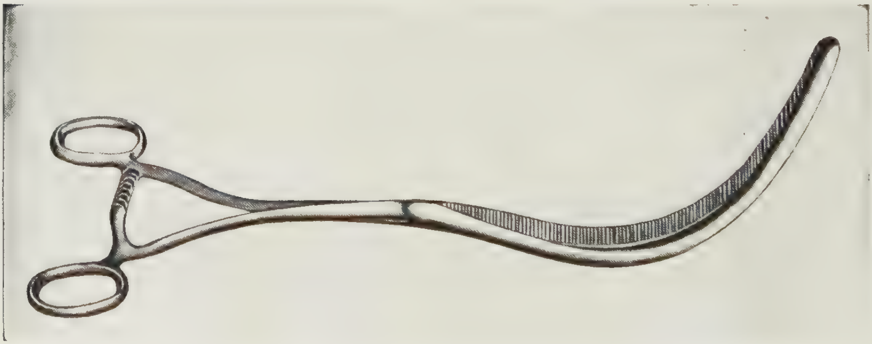


Fig. 3439.—Kocher's Full-curved Stomach Forceps

aration. Unless contraindicated the gastro-intestinal tract should be thoroughly cleared out by appropriate purgation several days in advance of the operation, and thereafter only receive simple fluid diet. The stomach itself should receive a daily lavage of sterile normal saline solution for two or three days in advance. The teeth should also be attended to in advance of operation. Nothing but sterile (non-tetanic) liquid nourishment should be administered for twenty-four hours prior to operation – or even longer. Naturally, in emergency operations, such as cases of stomach wounds, perforating gastric ulcers, and the like, much of what has been said would not only not be indicated, but contraindicated. Under the latter circumstances, preparations must be modified to meet the conditions present. In all cases the

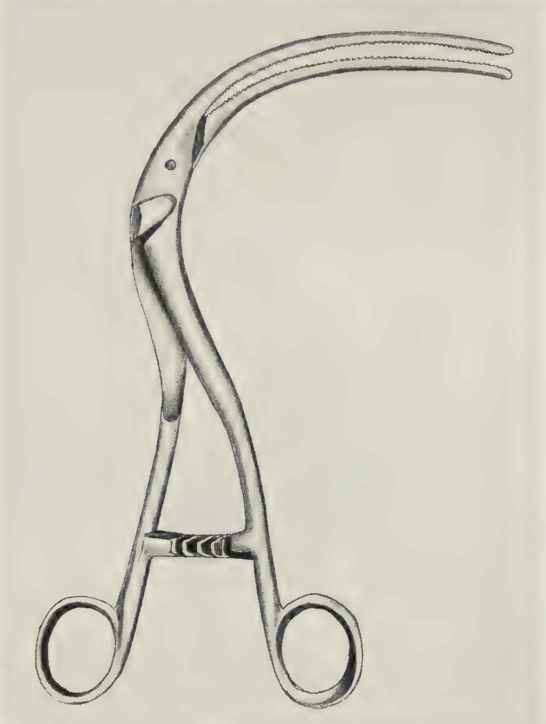


Fig. 3440.—Kocher's Anteroposteriorly Curved Stomach Clamp.

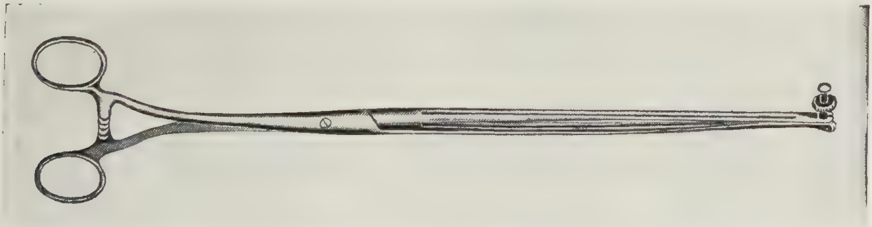


Fig. 3441.—Scudder's Straight, Fenestrated Stomach Forceps.

skin preparation should be as thorough as possible. Burghard, in connection with stomach operations, has called attention to the fact that while the skin may be sterile at the beginning of operation, its surface will show, by laboratory tests, bacteria present upon its surface and on its cut surfaces during operation — the bacteria of the glandular and other receptacles of the skin having been forced out in the manipulations. He advises, to counteract this, the clamping of several layers of gauze, or its equivalent, right up to the wound margins, as soon as the abdomen is opened.

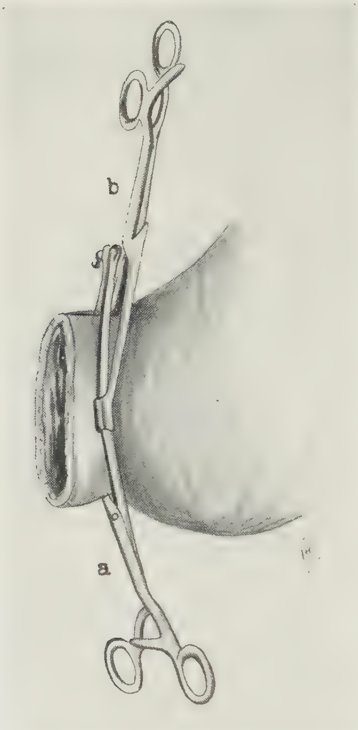


Fig. 3442.—Application of Hertel's Forceps, b, for Reinforcing the Closed Stomach Forceps, a.

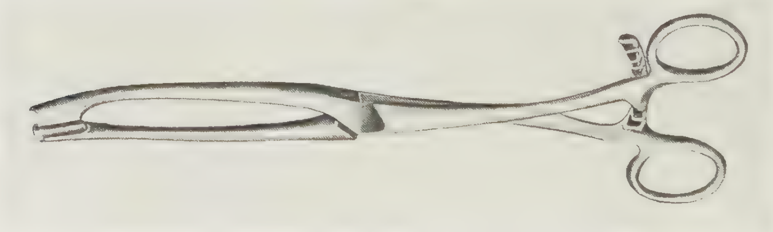


Fig. 3442a.—Hertel's Clamp for Closing Stomach Clamps.

Note.—Other general surgical considerations will be mentioned under the special classes of operations, and under the individual operations, as they are taken up.

GENERAL INSTRUMENTS USED IN OPERATIONS UPON THE STOMACH

Instruments required in abdominal section (p. 85): – scalpels; blunt-pointed bistouries, straight and curved; scissors, sharp, blunt, straight, curved; artery-clamps; forceps, plain and toothed; wound-retractors, special; broad spatulæ; stomach-clamps, of special and various types; intestinal clamps; taped, clamped and counted abdominal pads; stomach-tube; rubber tubing; Murphy buttons and other special gastro-intestinal buttons; catgut ligatures; wound-hooks; needle-holder, needles, straight and curved; suture material, silk, catgut, linen, silkworm filament.

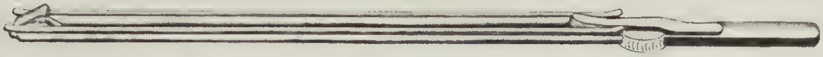


Fig. 3443.—Richard's Stomach Clamp.

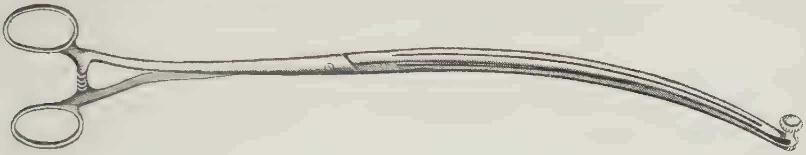


Fig. 3444.—Scudder's Curved, Fenestrated Stomach Forceps.

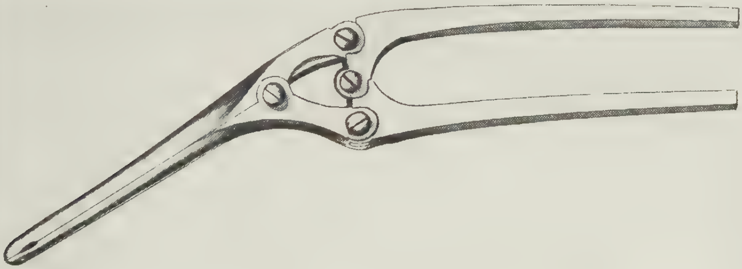


Fig. 3445.—Payr's Pylorus Clamp.

The rôle of the stomach-clamp in gastric operations is important and varied – and many types have been devised – of which some of the more important are shown in Figs. 3436–3445, but less use is now being made of clamps.

ESOPHAGEAL GASTROSCOPY

Description.—The visual examination of the interior of the stomach by means of a gastroscope, introduced by the oro-esophageal route. In some forms of gastroscope, especially originally, lenses and prisms were used. In gastroscopes of the Jackson type, no optical apparatus is employed – the gastric mucosa is examined by direct vision, through a straight tube, illuminated at its distal end by an electric lamp, and with an attached drainage-tube passing down its course. The examination is made under anesthesia _ the instrument is passed by sight _ and the stomach, previously lavaged, is further mopped dry through the instrument, and its entire mucosa systematically examined. The method is especially useful in the localization of cancer, ulcers, foreign bodies, and the like. The technic with the Jackson outfit will be described:

The Jackson Gastroscope (Fig. 3446).—The outfit consists of the handled tube, obturator, illuminating conduit, and electric lamp, and attached drainage-tube. The instruments vary in dimensions _ from tubes of 45 cm. ($17\frac{3}{4}$ inches) in length, and 7 mm. ($\frac{1}{4}$ inch) in diameter, for children _ up to tubes of 80 cm. ($31\frac{1}{2}$ inches) in length, and 10 mm. (6/16 inch), for adults _ with intervening sizes _ and Jackson even using a maximum tube of 11 mm. (7/16inch) in one diameter, and 14 mm. (9/16 inch) in the other.

Position of the Patient.—Formerly Jackson placed the patient upon his back, in a midposition between the horizontal and Trendelenburg's. The patient is now placed horizontal, until the passage of the tube, after which, the head of the table is elevated 30 cm. ($11\frac{3}{4}$ inches) higher than the foot.

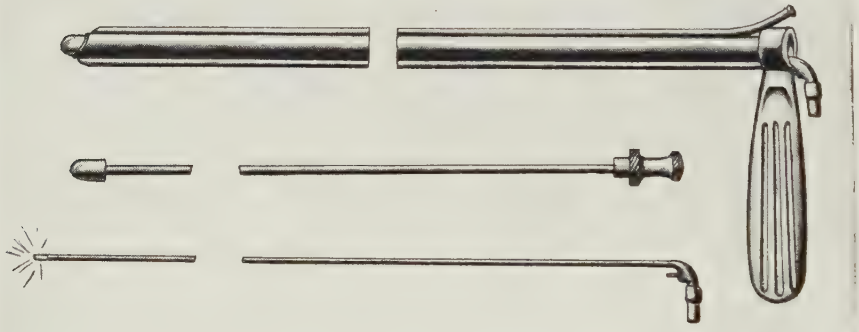


Fig. 3446.—THE JACKSON GASTROSCOPE _ Showing the instrument assembled. The detached electric globe and carrier and the obturator are separately shown. The auxiliary drainage-tube is seen attached to the upper part of the tube.

The patient's mouth is gagged on the left _ and the upper part of his body is drawn toward the Operator, until his shoulders project from 10 to 15.3 cm. (4–6 inches) beyond the table. The rôle of the Second Assistant is important _ and his duty is to keep the head in extreme extension, with the mouth widely open, and the mouth, pharynx, and esophagus in one straight line _ steadying at the same time the gag. He sits upon a stool at the patient's right _ with his right leg in the kneeling posture, and his left foot supported upon a stool 66 cm. (26 inches) lower than the surface of the table. He passes his right forearm under the patient's neck, and supports it _ while his right hand steadies the mouth-gag. His left hand, resting upon his left knee, holds the top of the patient's head, directing it backward and upward _ the backward and upward inclinations being determined by the requirements in the individual case, to straighten the oro-pharyngo-esophageal tract.

Passage of the Gastroscope.—The instrument, held in the right hand, is lubricated _ and force is at no time used in its passage _ the necessity for using force being sufficient indication that something is wrong in the parts, or in the technic. Having examined the esophageal opening with laryngeal mirror, or speculum, introduce the left forefinger into the patient's right pyriform fossa – and, on this, carry the gastroscope backward and downward as a guide. While causing the descent of the tube, practice slight upward leverage upon the base of the tongue, the epiglottis, and the cricoid cartilage, in turn – the last being out of finger reach. If the tip of the instrument is well engaged in a normal right pyriform sinus, it tends to drop into the esophagus. In the unusual cases in which difficulty is experienced, a flexible bougie may be passed through the gastroscopic tube as a guide.

As soon as the tip of the instrument enters the esophagus, raise the patient's head somewhat, withdraw the obturator, and turn on the light – as the tube travels thenceforth under direct vision – the path along which the tube is to travel, being first brought under examination before each new advance is made – the tube not being advanced until its route is seen in advance, by the opening up and rolling out, as it were, of the esophageal lumen, which tends to expand with each inspiration. Keep to the axis of the esophagus – upward pointing of the end of the instrument tending to cause embarrassment by compression of the trachea. After passing the introitus, the diaphragmatic hiatus, and the subphrenic part of the esophagus present the sites where trouble is most apt to be experienced. As the diaphragmatic hiatus is approached, cause the longer axis of the elliptic tube to assume a position corresponding with the longer axis of the hiatus (which lies obliquely from behind forward, and from right to left). Slight pressure of the engaged instrument at this point, or brief deepening of the anesthesia, will aid in enabling the instrument to pass this partial barrier. Having passed the diaphragmatic hiatus, the tip of the instrument enters the abdominal esophagus. Some confusion is apt to occur here, owing to the lessened patulousness. The esophageal mucosa is seen in axial folds, and the way seems blocked – the folds seeming to converge toward the left, to an ill-defined transverse slit. As the tube advances, these folds recede – until, finally, the opening of the cardiac orifice is demonstrated, which is circular, if the parts be in repose, but appears to be drawn by folds radiating from left to right when a condition of spasm is present. Anesthesia is increased during the passage of the diaphragmatic hiatus, the subphrenic esophagus, and the cardiac orifice. It may be somewhat easier to pass the abdominal esophagus if the patient's head and neck be directed to the right. The passage of the instrument is shown, in sectional view, in Fig. 3447.

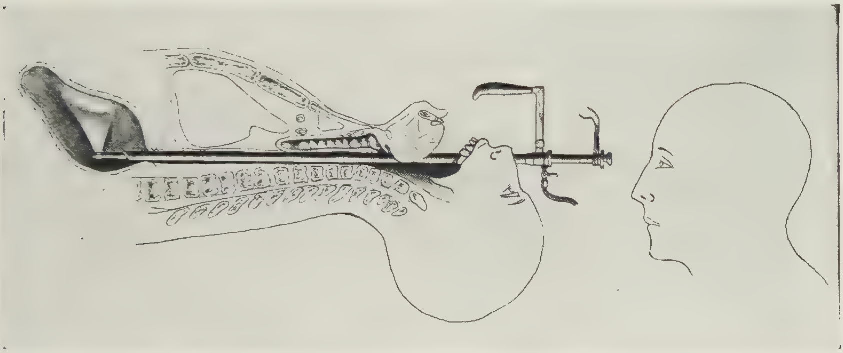


Fig. 3447.—Sectional View of the Passage of the Gastroscope.

On passing the cardiac opening and entering the stomach, one should work on a fixed plan of examination, as only a limited view can be seen at a time. This is best accomplished by examining the walls of the stomach, first in vertical, and then in horizontal strips, or panels. If the stomach be well collapsed, opposite walls may be examined in the one transit of the instrument _ otherwise, a separate excursion must be made for each wall. In examining by vertical strips, carry the tube from the lesser to the greater curvature, in a straight line _ then shift the instrument slightly to the right (or left), and examine, by withdrawing the instrument, from greater to lesser curvature _ when a new panel is taken. If opposite walls cannot be simultaneously examined, this must be repeated for each wall. Then the examination in horizontal strips should be carried out _ which is accomplished by lowering the tip of the instrument to the greater curvature _ and sweeping from cardia to pylorus on this level _ then, withdrawing the instrument somewhat, sweep across in the opposite direction, at a slightly higher level, as the pendulum of a clock swings, backward and forward _ until both walls have been simultaneously examined, or each one separately. Such an examination requires about half an hour _ and the examination is helped, if an Assistant will palpate the unexplored portion of the stomach from without, in front of the progressing tube _ and is also helped if the patient be turned from side to side during the séance (the gastroscope being withdrawn into the esophagus during the turnings _ and above the diaphragm, if retchings occur). Upon the completion of the examination, the instrument is carefully withdrawn.

Comment.—The vertical depth of the stomach is determined by learning the distance from the teeth to the cardia (v. Comment, p. 237) _ and then the distance measured through which the instrument has to be further passed down before reaching the greater curvature.

In making the lateral swings along the greater curvature, as the horizontal strips of the stomach are examined, if the tip of the instrument tends to carry the lower curvature along with it, it is slightly withdrawn, and then pushed down to the curvature in a new place.

Vertically placed stomachs and the stomachs of the very young afford the greatest range for examination _ and the more horizontally the organ is placed, the more limited the range.

The lateral range in movement of the diaphragmatic hiatus aids greatly in the lateral sweep of the examining gastroscope _ and further range is secured by turning the patient's head and neck to the side. The pivotal point of the gastroscope lies in the thorax (and not at the esophageal entrance, or diaphragmatic opening) _ and the end of the instrument can usually be made to point to both right and left superior iliac spines. The pylorus can generally be passed and the duodenum be entered.

The dangers of gastroscopy, in experienced hands, are those of anesthesia. The chief difficulties are those of inexperience in the technic, and physical deformities or defects of the patient. Several forms of gastroscopes are in use, constructed with and without lenses and prisms.

LAPAROGASTROSCOPY

This is the examination of the interior of the stomach through a gastrotomy wound _ by means of some form of tubal instrument. A rectal speculum may be employed _ bringing as much of the empty stomach wall into the field as possible. The stomach may be partly filled with water (holding the stomach wound uppermost) and its inner wall examined with a cystoscope. The method is but rarely employed _ and is chiefly of use in examining the cardiac aspect of the stomach.

INTRODUCTION OF THE STOMACH-TUBE—GASTRIC LAVAGE

Description.—The passage of a hollow rubber tube down the esophagus and into the stomach — for the purpose of either removing fluid from or throwing fluid into the stomach. The fluid usually enters the stomach by gravity, sometimes under pressure — and is ordinarily withdrawn by siphonage, sometimes by suction. Filling and emptying the stomach, in repeated turns, constitutes gastric lavage.

Position.—If the patient's condition warrants it, he sits upright in a chair, or in bed — with his head thrown backward, and mouth well opened. Patient and Surgeon are aided, if the former be steadied by an Assistant, standing or sitting behind him. The mouth is often gagged — which is helpful, but not generally necessary. A napkin is placed over the tongue, to enable it to be the more easily grasped and held. The Surgeon stands in front of the patient, so that his right hand is directly before the patient. In cases where the patient cannot sit up, the tube may be passed, often with but little additional difficulty, while he is lying down. In the very nervous, cocain solution may be applied to the uvula and palatal arches.

Passage of the Tube.—The Surgeon grasps the tube about 15.3 cm. (6 inches) from the end, holding it as he would a pen, in his right hand — while he passes his left index-finger into the patient's widely opened mouth. Depressing the base of the tongue, while gently hooking it forward with his left forefinger, he steadily and firmly passes the tube backward, until he feels its end in contact with the posterior pharyngeal wall — the left forefinger thus simultaneously depressing the base of the tongue, drawing it forward, and guarding the larynx. The tube is generally first dipped in warm water — though the deadening effect of ice-water is preferable to some people. It is rarely necessary to lubricate the tube (which is unpleasant to most people) — as the fluids of passages usually suffice for this purpose. As soon as the distal end of the tube is felt to be in contact with the pharyngeal wall, it is given a downward direction by the Surgeon's left finger — while, simultaneously, it is fed onward and downward with the right hand — always hugging the posterior pharyngeal wall, until the tip is well engaged in the esophagus. The progress must be boldly continuous — which is the best way of overcoming the gagging which so often occurs at the passage from the pharynx into the esophagus. The passage of the instrument is materially aided if the patient will voluntarily swallow during its advancement. Breathing soon becomes comfortable — and the tube is passed continuously onward, until its tip enters the stomach — as shown by the dental marking on the tube.

If the contents of the stomach be fairly liquid, they may be siphoned off at once — but if thickened by glairy mucus and solid contents, the outward flow is made easier by first throwing additional fluid into the stomach.

The fluid usually employed in stomach lavage is a weak bicarbonate of soda solution, tepid warm. Normal saline solution is sometimes used — but may nauseate some people — as also may tepid, rather than distinctly warm water. The fluid is usually poured into a funnel attached to the tube — not more than 10 to 12 ounces being thrown in at first, and with the funnel held only sufficiently higher than the level of the stomach to enable the water to flow. As soon as the patient complains of discomfort, the funnel should be lowered below the level of the stomach, and the fluid siphoned off — when the cycle may be again carried out.

At the end of the procedure the tube is carefully withdrawn.

Comment.—In the average adult, the distance from the upper incisor teeth to the superior end of the esophagus is given as 14 cm. (5½ inches); —

from the same point to the arch of the aorta, as 23 cm. (9 inches); _ and from the same point to the diaphragmatic opening, as 37 cm. (14½ inches). Pouches and diverticula of the esophagus are to be avoided.

No tube should be used which is not in good condition _ strong, perfectly smooth, and scrupulously clean.

The funnel-and-tube outfit usually suffices _ but sometimes a valve-bulb is attached _ so as to supply active force.

A mouth-gag is indicated in children, and in unconscious or rebellious patients.

After the first passage, subsequent passages are usually but slightly unpleasant.

The repetitions of the fillings and emptyings are generally repeated until the stomach fluid comes back clear.

EXPOSURE OF THE STOMACH—AND GASTROTOMY—BY MEDIAN OR PARAMEDIAN INCISION

Description.—Exploratory gastrotomy consists in the temporary opening of the stomach by incision _ followed by its closure at the same operation. The minimum damage to the structures of the abdominal wall is sustained by an incision in the median line, or just to one side of it, with the temporary lateral displacement of the rectus muscle. Approach by the subcostal route will be mentioned below.

Indications.—The usual purposes of gastrotomy are the following: _ Removal of foreign bodies from the stomach; _ Removal of foreign bodies from the lower end of the esophagus; _ For the control of gastric hemorrhage; _ For exploration; _ For the radical tratment of gastric ulcer; _ For the removal of pedunculated gastric tumors; _ For the dilatation of an esophageal stricture; _ For the dilatation of a pyloric stricture; _ In connection with some operations upon the posterior wall of the stomach; _ In some wounds.

Preparation.—In emergency cases no preparation of the interior of the stomach is ordinarily indicated, or possible. In planned, non-urgent cases, opinions differ as to preliminary gastric washings _ probably the majority being in favor of such preparation (see Gastric Lavage, p. 237).

Position.—The patient is supine _ the Surgeon stands to the patient's right, cutting from above downward _ the Assistant stands opposite.

Landmarks.—The xiphoid cartilage, linea alba, and umbilicus.

Anesthesia.—Is usually employed _ although analgesia may be used in special cases.

Incision.—The approach may be either by the median or paramedian abdominal section: _ (*a*) Median Section (which gives somewhat better access to the median aspect of the stomach) is made in the median line _ its center being about opposite the space between the eighth and ninth costal cartilages _ and extending toward, or to the tip of the xiphoid cartilage, above _ and toward, or to the umbilicus, below _ as the circumstances of the case require (Fig. 3448, **b**). The incision is usually from 5 to 10 cm. (2–4 inches) in length _ and is made in one sweep of the knife, from its highest to its lowest point. (*b*) Paramedian Section (a right paramedian incision giving better access to the pyloric aspect of the stomach, and a left paramedian incision, to the cardiac aspect) is made vertically over the right, or left rectal sheath (as just explained), parallel with the median line and at a distance of about 2 cm. (¾ inch) from it _ beginning at the costal arch, above, and extending downward for about 7.5 cm. (3 inches).

Operation.—If the approach be by median incision, the steps are conducted as in Median Abdominal Section (q. v.) _ up to the opening of the peritoneum. If the approach be by the paramedian incision, the steps are conducted as in Paramedian Abdominal Section (q. v.) _ up to opening the peritoneum. In the latter method, it is preferable to incise the anterior rectal sheath, expose and retract the rectus muscle outward, and then correspondingly incise the posterior rectal sheath _ than to divide the rectus muscle even in the direction of its fibers.

The margins of the abdominal wound are retracted _ and the stomach sought _ the steps for its recognition being given under General Surgical Considerations _ for, as strange as it may seem, the large viscus is not always easily located, and at once indisputably recognized. If any prolonged search be required, or difficulties of adhesions encountered, care should be taken to avoid stripping the peritoneum from the abdominal wall. Having located the stomach, that portion of its anterior wall into which the incision is to be made must be isolated and drawn out of the wound by means of the fingers, or special traction-forceps, the general peritoneal cavity being packed off with gauze pads. The site of the opening into the stomach will depend largely upon the nature of the operation. An assistant grasps the anterior stomach wall toward either side of the retracted abdominal wound, between his thumbs and fingers, steadying and spreading out that surface _ or temporary silk traction-sutures may be passed, with curved needle, into the stomach wall,

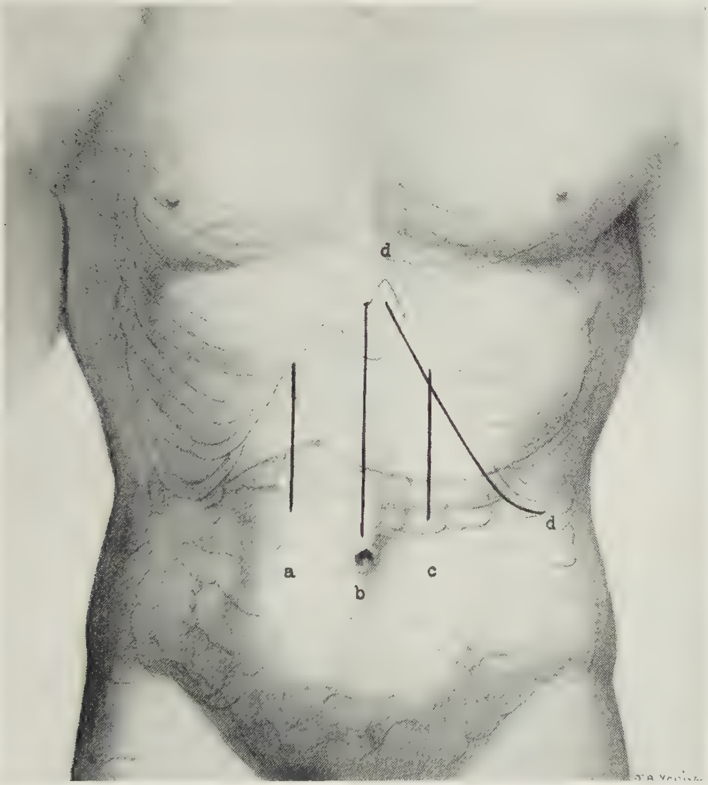


Fig. 3448.—The More Usual Incisions for the Exposure of the Stomach: _ **b**, Median; _ **a**, right paramedian; _ **c**, left paramedian; _ **d**, **d**, left subcostal.

without entering its cavity – thus exposing an area of about 5 to 7.5 cm. (2–3 inches) of the anterior wall. This area having been put upon the stretch, an opening of about 3.7 to 5 cm. ($1\frac{1}{2}$–2 inches) is made in the vertical axis of the stomach, parallel with the blood-vessels – or it may be made parallel with the long axis, avoiding large vessels. This opening may be made by a quick, controlled stab of a narrow, sharp bistoury, penetrating all the coats, and then enlarged with blunt-pointed bistoury – or it can be more deliberately made by a pair of scissors, picking up a fold of stomach wall and cutting through at right angles to the fold. Two temporary traction-sutures are at once placed in the opposite lips of the stomach wound, to hold them in control, and to enable the interior of the stomach to be exposed by retraction of its walls. The stomach opening may be enlarged if necessary. Clamp and twist all bleeding vessels, carefully isolating and ligating with gut any requiring ligature. If indicated, the stomach may be washed out by suction drain, thoroughly protecting the abdominal cavity from soiling.

The object of the operation is now accomplished. The stomach wall is then sutured in the manner described under Gastrorrhaphy, page 244, – with a tier of sutures through the mucous coat, and an overlying tier of Lembert's through the outer coats – using, preferably, fine chromic gut. The stomach is then dropped back into place and the abdomen closed in the usual fashion.

Comment.—The above operation gives satisfactory access to all parts of the stomach – except that the extreme cardiodiaphragmatic aspect of the organ is naturally better exposed by the oblique subcostal incision, but at the cost of transverse muscle division.

If necessary to reach the posterior aspect of the stomach, the transverse colon should be drawn out into the wound – so as to make an opening through the gastrocolic omentum.

The transverse division of the stomach wall gives better exposure of the interior, but is accompanied by greater bleeding. All vessels should be clamped and tied with fine catgut, as divided.

If the cavity of the stomach is very much soiled, it is safer to cleanse its interior with gauze mops – than to use irrigant fluid, even if it is to be withdrawn by suction.

If it be necessary to examine the mucosa thoroughly, this may be satisfactorily accomplished by passing a couple of fingers through a tear in a comparatively bloodless part of the gastrocolic omentum, just below the stomach, behind the stomach, and protruding the posterior stomach wall through the incision in the anterior stomach wall. In this way practically all of the stomach wall may be passed before the Surgeon in review.

It is better to close the mucosa with catgut, and the musculoserous coats with silk, or Pagenstecher.

All protruding and obstructing viscera are held out the field by large gauze pads (counted, taped, and clamped).

In exploring the esophagus, it is to be remembered that the esophagus, in entering the stomach, tends, or turns, toward the patient's left – and that his finger should be directed obliquely to the right. The opening is not always easily found, and is concealed in a fold of mucous membrane.

Besides the main tier of large laparotomy pads walling off the general peritoneal cavity and holding back the viscera, a secondary layer of smaller pads should immediately protect the operation site, before the stomach is opened.

The region of the stomach to be incised by knife is conveniently ridged up by means of two traction-sutures, or two volsellum-forceps, placed just beyond the limits of the cut. If the stomach wall is to be cut with scissors, the ridging-up must be directly at a right angle to the line the scissor-cut will make.

When the work upon the stomach itself is finished, gloves and all instruments should be changed, before proceeding to close the abdomen. It is even wiser, though somewhat extreme, to make the first such change as soon as manipulation with the interior of the stomach is finished, before suturing the gastric wound – and then make a second change before closing the abdomen.

After intragastric operations stomach feeding should be withheld for two or three days.

If it be desired to make a very thorough examination of the posterior wall of the stomach, by palpation, this may be accomplished, in the absence of extensive adhesions, by inserting the fingers of one hand through an incision in the gastrocolic omentum, and those of the other hand through an incision in the transverse mesocolon – so that the fingers meet upon the posterior wall of the stomach – as shown in Fig. 3449.

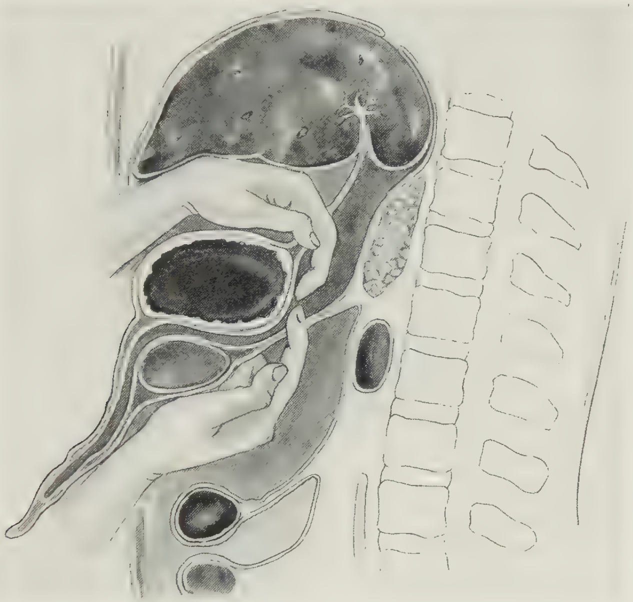


Fig. 3449.—Bimanual Palpation of the Posterior Wall of the Stomach; – The fingers of the left hand are passed through the gastrohepatic omentum – and those of the right hand, through the transverse mesocolon – meeting upon the posterior stomach wall in the lesser peritoneal cavity.

EXPOSURE OF THE STOMACH—AND GASTROTOMY—BY OBLIQUE SUBCOSTAL INCISION

Description.—The stomach is opened by an incision parallel with and below the left costal arch – which more conveniently exposes the extreme cardiac end of the stomach, and the cardiac orifice of the esophagus – but at the cost of considerable transverse muscular division. It is not, therefore, warrantable when the ends can be accomplished by the left paramedian incision described in the preceding operation. In the case of some large bodies firmly impacted at the esophageal opening, and in some otherwise inaccessible tumors, or wounds, this route may have to be chosen. In such an event, effort should be made, at the end of the operation, to repair, as well as possible, all harm done by transverse and oblique muscular cuttings.

Preparation _ Position.—As for Median Gastrotomy.

Landmarks.—Xiphoid cartilage; left costal arch.

Incision.—Begins near the tip of the xiphoid cartilage and extends thence downward and outward, parallel with and about 2.5 to 3.7 cm. (1–1½ inches) to the inner side of the left costal arch, ending about opposite the anterior end of the ninth rib, _ generally extending for a distance of about 7.5 cm. (3 inches), varying with the thickness of the abdominal wall (Fig. 3448, D).

Operation.—Incise through skin and fascia, clamping all bleeding vessels. The incision will pass through the fibers of the external oblique at about a right angle to their course, _ will pass between the fibers of the internal oblique, _ and will divide those of the transversalis transversely to their course, _ but will pass more or less parallel with the seventh and eighth nerves, which, if possible, should be recognized and drawn aside. The peritoneum is opened in the line of the original incision _ the stomach is recognized _ isolated _ and drawn into the wound, the general peritoneal cavity being well packed off _ and its anterior wall is opened in the same general way as described in Median Gastrotomy, and in the special site selected. The object of the operation having been accomplished, the stomach wall and the abdominal wound are closed in the manner just described. Damage to the musculature is repaired as fully as possible.

Comment.—(1) The above operation is very similar to that of Gastrostomy by the same incision. (2) Large, irregular, impacted bodies are sometimes removed by incisions made directly over them and giving access by the nearest route. (3) Exposure may also be made by chondroplastic resection of the left costal arch. (4) The inner wall of the stomach may be very completely examined, in the following manner: _ the gastrocolic omentum is incised vertically, between vessels, and the hand carried into the lesser peritoneal cavity, with the palm of the hand forward _ after which the posterior wall of the stomach is inverted (by the motion of closing the fingers) into the cavity of the organ _ and may even be brought entirely through the anterior gastrotomy wound (Fig. 3547).

EXPOSURE OF THE CARDIAC ASPECT OF THE STOMACH BY THE TEMPORARY RESECTION OF THE LEFT COSTOCHONDRAL ARCH

BAUDET-NAVARRO TECHNIC

Description.—This exposure is accomplished by temporarily turning upward a composite flap, consisting of the overlying soft parts and the two lowest ribs of the left costochondral arch _ thereby securing access to the lowermost part of the esophagus, cardiac end of the stomach, dome of the left aspect of the diaphragm, and the left pleural cul-de-sac.

Operation.—The primary incision is carried through the superficial cutaneomuscular coverings _ beginning over the sternum, opposite the upper border of the fifth left costal cartilage, just to the median side of the left sternal border, and passes thence straight downward to a little below the junction of the last costal cartilage with the sternum _ thence it passes outward parallel with the left costal arch, and at a distance of about 1.5 cm. (½ inch) from it, thus leaving room for the suturing of the costal and abdominal parts of the cut abdominal muscles _ until the anterior axillary line is reached, when the incision turns upward, crossing the seventh and sixth ribs (Fig. 3450).

The costal cartilages are divided at a distance of 1.5 cm. (½ inch) from the left sternal border. The ribs are divided on a line which will be perpendicular to the subcostal division of the soft parts _ which will not be exactly parallel with the division of the cartilages at the sternal end, but rather tend toward the scapula _ and, for that reason, will make the uplifting of the osseocartilaginous flap easier.

Two methods are available for raising the composite flap: _ (*a*) The flap of overlying soft parts is first raised, including all the soft structures down to the plane of the ribs, cartilages, and intercostal muscles (Fig. 3451). And after this, divide the last two (or three) vertebrosternal ribs, posteriorly _ and their corresponding cartilages, anteriorly _ and thereby free and raise an underlying flap of ribs, cartilages, and intercostal muscles; _ or (*b*), all of the soft parts are first incised, but not raised, after which the ribs and cartilages are divided along the lines above indicated, and the entire composite flap raised in a single layer _ hinging on the soft parts between the uppermost severed rib and the first unsevered one above. The former method is easier _ and is the one illustrated. Care is used not to tear the intercostal muscles.

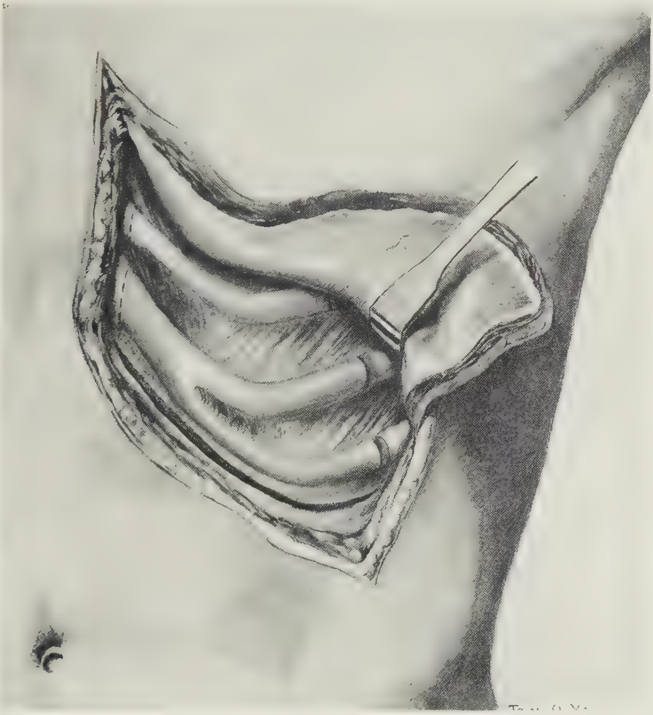


Fig. 3450.—Exposure of the Cardiac Aspect of the Stomach by the Temporary Resection of the Left Costal Arch _ Baudet-Navarro Technic _ I; _ The flap incision.

On opening the abdomen and elevating this flap, the cardio-esophageal and cardiac aspects of the stomach and dome of the diaphragm are exposed.

Upon the completion of the operation, the osseocartilaginous and soft flaps are turned back into place. While the ends of cartilages and ribs are not always drilled and sutured with chromic catgut or kangaroo-tendon, it is best to do so. The divided muscles are brought together and carefully sutured along the subcostal line of their division _ and, finally, the flap of

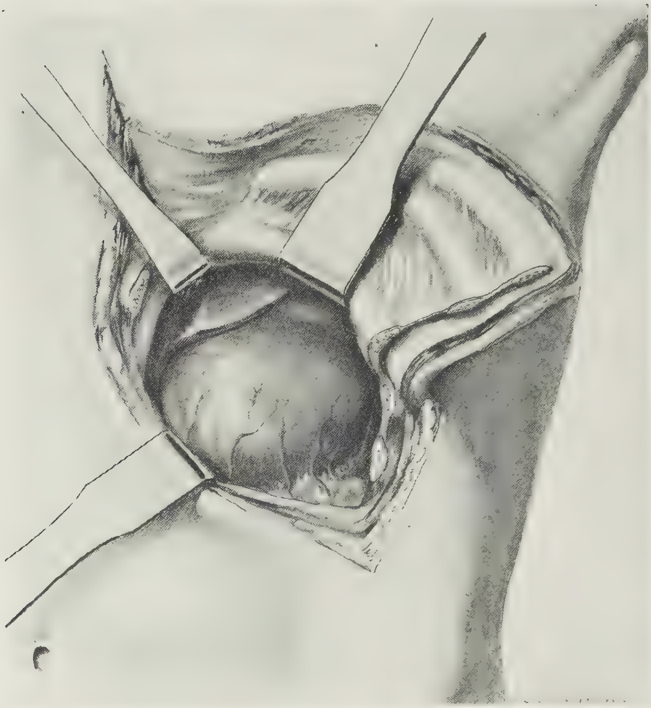


Fig. 3451.—The Same – II; – The flap of superficial soft parts, and the flap of cartilages, ribs, and intercostal muscles, have been raised and turned upward – exposing the cardia and cardio-esophageal opening.

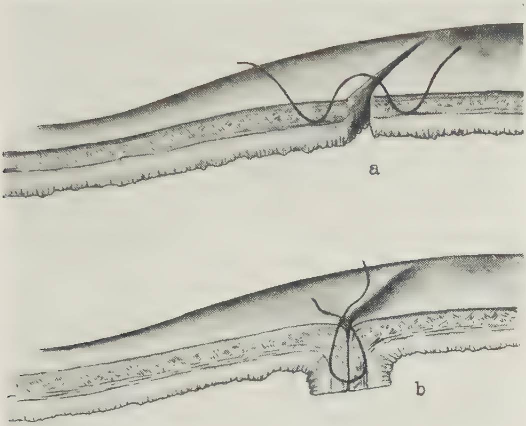
overlying skin, fascia, and superficial muscles. Provision is made for the exit of a drain from the abdomen, through the suture line, if necessary.

GASTRORRHAPHY

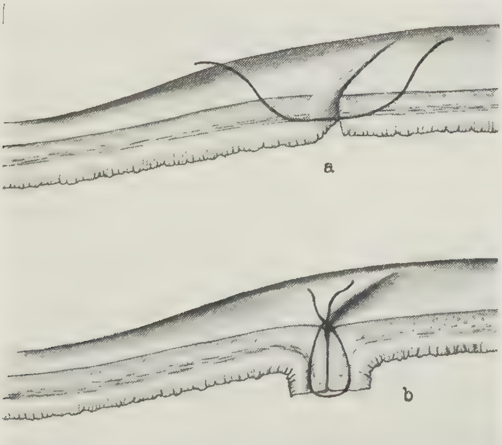
Stomach suturing is, of course, only the closing stage of some operation upon the stomach performed for definite purpose – usually, either the repair of a wound of the organ, or, more generally, the closure of wounds of the stomach, following operation. Only, therefore, will the feature of suturing be here considered.

The chief feature of stomach suturing, as of intestinal suturing, is the approximation of relatively broad surfaces of the serous coat – whether it be the only layer of suturing, or whether it be the outer of two tiers of sutures. The basis of all modern suturing of the serous portions of the gastro-intestinal tract is the Lembert type of suturing. This has been variously modified – and the best type of suture for the stomach wall is the Lembert-Albert stitch. The Lembert, Lembert-Czerny, and Lembert-Albert sutures will be here described.

(*a*) **The Lembert Suture.**—This single-tier stitch includes the serous and muscular coats of the stomach only, and does not include the margins of the wound. A round-needle is used – and enters the stomach wall about 5 mm. (3/16 inch) from the wound – penetrates serosa and muscularis – and emerges about 1 mm. (1/24 inch) from the wound margin, – after which, it passes over to the opposite side and enters the stomach wall about 1 mm. from the wound margin _ penetrates serosa and muscularis _ and emerges about 5 mm. from the point of entrance _ as shown in Fig. 3452, **a**. When the suture is tied (Fig. 3453, **b**), serosa is approximated to serosa _ and no part of the suture serves as a drain from the cavity of the stomach, outward. It is to be noted that the suture must *not* be introduced (as is sometimes done) as shown in Fig. 3454, **a** _ where (although strictly a Lembert stitch) it includes the margins of the serosa and mucosa _ for, when it is tied, a part of it projects into the interior of the stomach, and offers a drain outward for possible peritoneal infection _ as shown in Fig. 3455, **b**. The single-tier Lembert suture is, naturally, not as strong and safe as one of the modified, reinforced types.



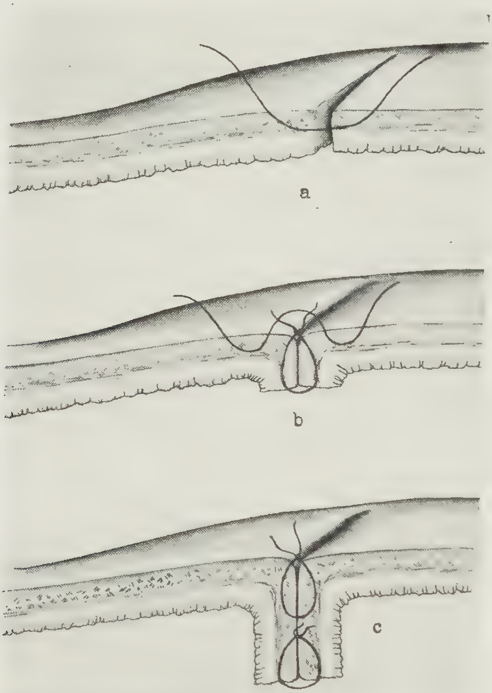
Figs. 3452 and 3453.—The Correct Lembert Suture of the Gastro-intestinal Tract: _ **a**, The non-marginal and proper placement of the Lembert suture, through the serous and muscular coats; _ **b**, the same, tied _ showing the blockage of infection from the interior of the viscus.



Figs. 3454 and 3455.—The Incorrect Lembert Suture of the Gastro-intestinal Tract: _ **a**, The marginal and improper placement of the Lembert; _ **b**, the same, tied _ serving as a continuous drain from the mucosa, outward.

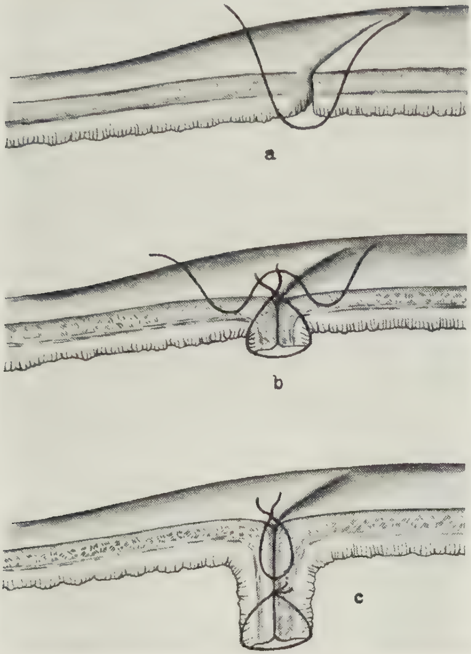
(*b*) **The Lembert-Czerny Suture.**—In this double-tier technic, a simple Lembert suture (of the type just condemned when used alone) is first carried through serosa and muscularis, up to and including the margins of the wound (Fig. 3456, **a**) – after which the first marginal Lembert is reinforced by a second non-marginal Lembert (Fig. 3456, **b**), which inverts the first suture downward and inward into the cavity of the viscus, but blocks any outward drainage from the cavity by the close approximation of broad surfaces of serosæ, as seen in Fig. 3457.

(*c*) **The Lembert-Albert Suture.**—This double-tier method represents the most secure and desirable type of suture for stomach or intestine. A through-and-through suture is first carried through all the coats of the margin of one side of the wound, from without inward – and then through all the coats of the opposite side, from within outward (Fig. 3458, **a**), after which it is tied (if an interrupted suture), constituting the main suture of strength. The second tier consists of non-marginal Lemberts (Fig. 3459, **b**), applied as above described. And when these are tied, they invert the first tier inward, burying it, but interposing between the first and second tiers an area of serosæ not invaded by suture, thus blocking outward infection from the viscus (Fig. 3460, **c**).



Figs. 3456 and 3457.—The Lembert-Czerny Gastro-intestinal Suture: – **a**, The placement of the marginal Lembert, through serosa and muscularis; – **b**, the tied marginal Lembert – and the placement of the superimposed non-marginal Lembert; – **c**, the marginal and non-marginal Lemberts are both tied, constituting the completed suture element (whether interrupted or continuous).

In placing the sutures, it is well to have the ends of the wound steadied by wound-hooks, or by traction-sutures (one of each being shown in Fig. 3461) – and in this way the margins of the wound are kept parallel, and prominently



Figs. 3458–3460.—The Lembert-Albert Gastro-intestinal Suture: _ a, The through-and-through suture, traversing all the coats of both sides of the wound margin; _ b, the first tier, of all the coats, tied _ and the placement of the non-marginal Lembert; _ c, sectional view of both tiers tied _ showing an area between the two, of approximated serosæ, blocking all outward drainage.

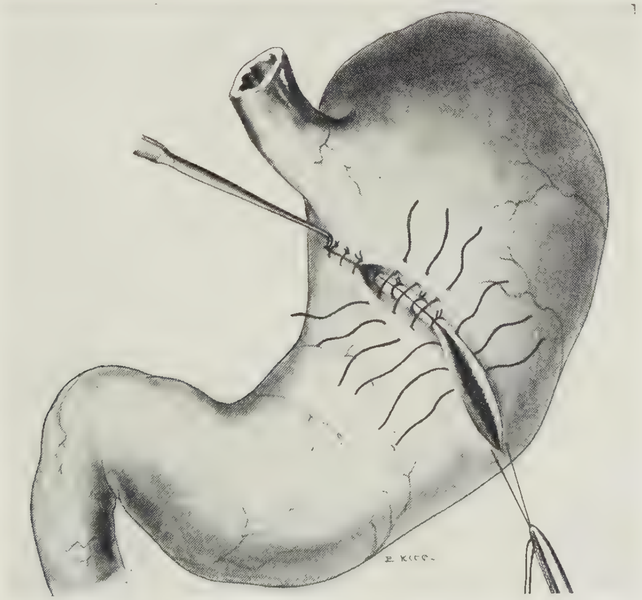


Fig. 3461.—Suturing a Stomach Wound; _ The margins of the wound are made parallel during the placing of the first, through-and-through tier of sutures, by tension with wound-hooks, or traction sutures (one of each being here shown). The second tier of non-marginal Lembert suturing is being placed

forward, while passing the first tier of through-and-through sutures – and the surfaces are steadied while passing the Lemberts – both of which technics are shown in the above illustration.

The sutures may be placed interruptedly, or continuously.

The suture material usually employed, is chromic catgut – though silk and linen are sometimes used. If non-absorbable suture material be employed in operations upon the stomach and intestines, interrupted sutures are better than continuous ones – for the degree of subsequent distensibility may be limited by the latter – and the pull upon an unyielding continuous suture line may tear the wall of the viscus. While this is theoretically true, practically, continuous suturing is usually employed in stomach surgery. While this is also sometimes (though not so systematically) done in intestinal suturing, it is the writer's judgment that it should never be done in the latter case, where room for distention without pull upon a continuous suture is especially limited in the case of the intestine.

All sites of gastric or intestinal suturing may be reinforced by omental grafts, as described and pictured at p. 220.

OPERATIVE TREATMENT OF INCISED AND GUNSHOT WOUNDS OF THE STOMACH

Perforating and penetrating wounds of the stomach are indications for immediate operation – as soon as diagnosed. The fact that many patients thus wounded get well without operation does not alter this status. It is interesting to note that Treves stated, as his view, that it was not advisable to operate in cases where the abdomen was traversed above the umbilicus, owing to the variety of injuries which were likely to be present – while in those cases where the wound traversed the abdomen below the umbilicus, the patients usually got well without operation (Moynihan).

Delay for the manifestation of definite phenomena of penetration frequently gives those phenomena time for harmful progress and, often, irreparable damage.

The patient is often in such a condition that the element of shock is to be contended with, in addition to the operative problem – the object of which is to discover and repair the wound of the stomach, and, quite often, of one or more neighboring structures.

The circumstances under which operation may not be imperative, or even indicated, are where a patient is not seen for two or three days after the injury – and is, at that time, doing well, and without symptoms of penetration of important viscera – or the indications of hemorrhage, or infection.

Operation.—Whether the stomach is exposed by a median abdominal section, as is more frequently the case – or through the enlargement of the wound of injury – or by resection of the left costal arch – will largely depend upon the position and nature of the wound. As extensive manipulation of the intra-abdominal structures is usually required, ample room for the carrying out of such manipulations should be secured – and this is generally best accomplished through the median line, unless the wound be well to the right or left, when a right or left paramedian section may afford freer approach. Analgesia or anesthesia will be employed, according to the general indications. On opening the peritoneum it should be observed whether any abnormal odor or fluid escapes, that might be expected with perforation of the hollow viscera.

If fluid be encountered on incising the peritoneum, this should be at once removed with a suction drain, or absorbed upon gauze sponges. Having accomplished this, the field of operation should be walled off with gauze packings from the rest of the abdominal contents. Elevation of the table will often aid the intestines to helpfully gravitate away from the stomach. The examination of the stomach for the wound is conducted along lines guided by the skin wound of entrance.

If the stomach be empty and the wound be small and sharply cut, very little leakage may occur – the wound being plugged by the mucosa. Incised wounds are apt to be smooth edged, and so may some bullet wounds – and require no preparation for suturing. In the case of wounds with ragged margins, it is often advisable to trim away such edges, which are apt to be partially devitalized. The usual method of closure is by two tiers of suture. The first tier is a through-and-through marginal stitch, made with fine chromic catgut, and including all the coats. This is followed by the second tier, which is a seromuscular stitch of fine Pagenstecher linen thread. The first tier is inverted and protected by the second tier. A very small circular wound is sometimes first closed by a purse-string suture before the seromuscular stitch is applied.

If the wound of the anterior wall of the stomach be a large one, it will sometimes admit of examination, through it, of the posterior wall of the stomach. Otherwise, to examine the posterior wall, the stomach should be elevated and an incision made in the gastrocolic omentum, avoiding prominent gastroepiploic vessels, or ligating them if cut.

It has happened that only a single wound is found – that which has penetrated the anterior wall of the stomach – and yet the ball which has not made its exit through the opposite wall of the stomach may, nevertheless, have wounded the mucosa of the opposite wall to such an extent that dangerous hemorrhage is still taking place from the broken vessels. In such cases the wound of the anterior wall must be enlarged, or a new wound made, and the source of bleeding from the wounded mucosa checked by ligation of the bleeding vessel.

The question of peritoneal drainage must be decided by the circumstances of the individual wound – independently of the fact that spilled fluids have been removed by suction, or sponging. This question is especially influenced by involvement of adjacent structures. Certainly if infective peritonitis have developed, drainage is indicated – and in cases of extensive soiling, temporary drainage is safest.

Finally, a complete toilette of the peritoneum is made – all displaced parts returned to their normal site – and the abdomen closed.

OPERATIVE REMOVAL OF FOREIGN BODIES FROM THE STOMACH

All foreign bodies which the Surgeon may be called upon to remove from the stomach are of extragastric origin. The vast majority are solely so – either having been swallowed, or having gotten into the stomach as wounding objects. Some, however, are of intragastric manufacture, out of extragastric materials – such as the hair-balls. The variety of swallowed objects encountered within the stomach seems only limited by the ability of the oro-esophageal tract to transmit the object.

The majority of objects which can be swallowed can be passed on through the pyloric orifice into the intestinal canal – and can generally be defecated. If the swallowed object is free from wounding projections, or other hurtful qualities, it sometimes remains in the stomach indefinitely, even for many months. Occasionally swallowed objects are vomited.

Operative Removal.—The technical procedure for the removal of foreign bodies from the stomach is through a gastrotomy wound – and the stomach is generally most conveniently exposed for the purpose through a left paramedian abdominal section. Having exposed the stomach, the foreign body is sought by palpation _ for the purpose of determining its size and position, as well as the length and position of the incision required through which to remove it with minimum damage to the stomach. The surrounding regions are carefully packed off with gauze pads to prevent soiling. The incision through the wall of the stomach should be made through a non-vascular region _ and, for that reason, is generally vertical in direction (that is, at a right angle to the long axis of the stomach). If an especially large wound be required, it should be made horizontally, through a region as little vascular as possible, between lesser and greater curvatures. The predetermined limits of the incision are conveniently seized with volsellæ (or by thread tractors through the outer coats) and put under slight tension. The stomach is thus drawn up into a ridge, along which extra gauze pads are placed _ after which it is incised at one end with a knife and the incision enlarged toward the other end with scissors. After all outflow is caught upon gauze, and while the outlet is held above the rest of the level of the stomach, forceps are introduced into the wound and the object sought and removed.

The margins of the wound are sutured with fine chromic catgut through all coats. The instruments and gloves are changed, the wound cleansed and repacked _ and the second tier of seromuscular Lemberts applied, consisting of fine Pagenstecher linen. The abdomen is closed in the usual way _ drainage being but rarely indicated.

Food by the stomach is withheld for forty-eight hours _ though, in small wounds, water may usually be carefully given in twenty-four hours.

GASTROLYSIS

Gastrolysis consists in the separation or division of perigastric peritoneal adhesions between the stomach and neighboring structures _ conducted as an operation in itself _ or as an incident in the course of some major operation.

These adhesions usually result from some pathologic process of the stomach, duodenum, gall-bladder, pancreas, vermiform process, or female organs, or occur as a result of operation _ or may be the reformed adhesions following a previous gastrolysis.

These perigastric adhesions are to be dealt with according to their nature and environment.

Limited, filamentous adhesions may usually be separated by a gauze-covered finger, through a process of rubbing them away, as it were. Somewhat stouter adhesions often require blunt dissection.

Cord-like or band-like adhesions should be divided between double ligatures.

Extensive dense and firm adhesions may require some degree of dissection, followed by repair of the wall of the viscus, or structure from which dissected.

Surfaces left raw by the operative procedures of freeing the adhesions should be so covered that re-adhesions will not occur. In many instances this can be accomplished by suturing serous surfaces together, _ and, in others, by omental grafting.

The matter of intraperitoneal adhesions is considered in detail at p. 203.

OPERATION FOR VOLVULUS OF THE STOMACH

Gastric volvulus is a rare condition, characterized by the assumption of a position by the stomach constituting, essentially, a torsion around an axis whose situation and direction vary somewhat, but which most frequently extends from the cardia to the pylorus.

The condition is favored by gastric ptosis, elongated gastric ligaments, and adhesions (such as may result from ulcers and from perigastritis).

The most common types of volvulus are the following (Deaver and Ashhurst): — (*a*) Torsion around a transverse axis (one in the frontal plane), where the stomach, viewed from in front, revolves as an advancing or retreating wheel (the latter being the commonest form of gastric volvulus); — (*b*) Torsion around an anteroposterior axis, where the stomach, as viewed from the patient's head, rotates either clockwise, or contraclockwise; — (*c*) Torsion around a longitudinal axis (one in the sagittal plane), at a right angle to the greater curvature) where the stomach rotates, as viewed from the patient's head, either clockwise, or contraclockwise.

Operation.—The treatment of volvulus is almost exclusively operative. The passage of a catheter, per oram, for the purpose of evacuation, may be tried, but is generally impossible — indeed, this impossibility is usually one of the diagnostic measures. If a catheter can be passed through the cardia and the stomach be evacuated, the operative conditions then become more favorable.

Upon opening the abdomen by median abdominal section, the stomach usually appears in the wound as a great cyst, stretched and covered by the mesocolon. The condition of tension generally prevents operative manipulation — until this tension is relieved by evacuation — which is accomplished either by trocar and cannula, or by incision, through a non-vascular part of the mesocolon, into the stomach. It is only after such evacuation can one make an investigation to determine the type of volvulus existing, the position of the vessels, and the attachment of the great epiploön. In this way only is it possible to undertake to intelligently untwist the twisted organ — which becomes a much easier process after the stomach is evacuated.

The special operative technic to be practiced in the case will depend upon the particular cause of torsion in that case — as well as upon the associated condition which may be met in the abdomen — and extensive procedures may be demanded.

The routine usually pursued, following the reduction of the torsion, is to perform a gastropexy — generally by the method of Beyea (p. 253).

The abdomen is closed as usual.

OPERATIVE TREATMENT OF ACUTE DILATATION OF THE STOMACH

Although acute dilatation of the stomach is comparatively rare, its occurrence is frequent enough — and, especially, serious enough — to demand the most active measures for relief, without which, death usually occurs within twenty-four or forty-eight hours.

The causation of acute gastric dilatation is, unfortunately, not definitely known. Its occurrence has taken place under various conditions, and associated with very different circumstances — so as to make the tracing of its etiology very difficult.

It has been encountered in connection with various medical conditions, such as pneumonia and typhoid fever — and, as well, as a primary involvement, without the association of any known pathologic state. It has, however, been most frequently encountered as a postoperative occurrence — but even here, in connection with no particular class of operations, having followed extra-abdominal as well as intra-abdominal operations (though generally the former). Those cases which occur in connection with pyloric obstruction, with volvulus of the stomach, and the like, are reasonably explained. An atonic state of the stomach, and overfilling the organ with food or fluid, have been considered responsible for some cases. Various other causative influences have been ascribed, such as toxemias, chronic gastrectasia, unusually long mesentery, traction upon the mesentery, duodenal obstruction, and the like.

The appearance of an acutely dilated stomach is seen in Fig. 3462.

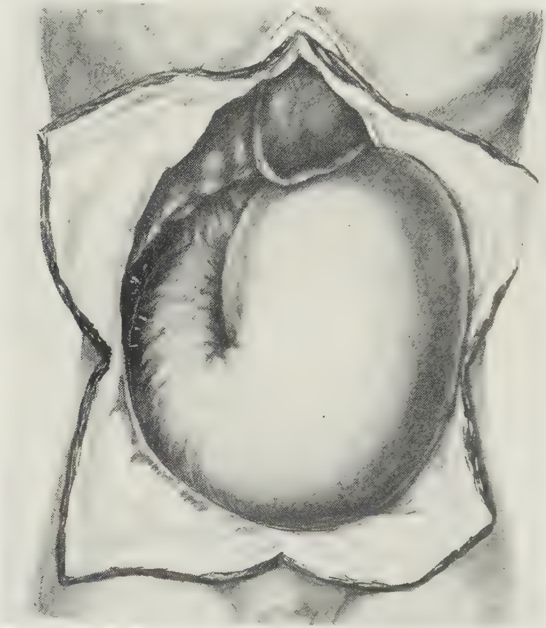
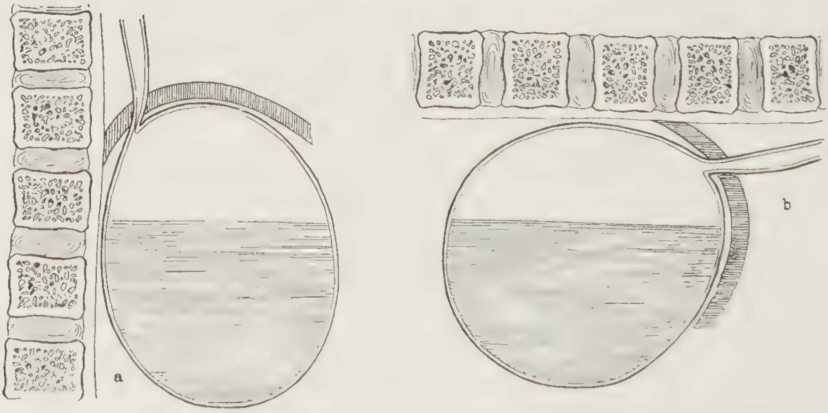


Fig. 3462.—Representation of an Acutely Dilated Stomach.



Figs. 3463 and 3464.—Diagrammatic Representation of Influence of Posture in Acute Dilatation of the Stomach: – a, Erect posture, showing the occlusion of the cardiac orifice by intragastric gaseous pressure; – b, prone posture, showing how the weight of the intragastric fluid tends to pull the anterior aspect of the cardiac orifice downward and open, while, simultaneously, the pressure of the intragastric gas tends to push the posterior aspect of the cardiac orifice upward and open.

Frequent lavage and evacuation of the stomach – as well as the "belly posture," with face downward – should be first thoroughly and promtly tried. The object of the prone postural treatment is shown diagramatically in Figs. 3463, 3464. The pelvis should be higher than the diaphragm. The knee-chest position may be assumed. These measures have been successful in a certain percentage of cases. Failing in these, immediate operation is indicated.

The operative treatment which has been most frequently and successfully employed is gastrojejunostomy (p. 300). Gastrostomy has been less successfully performed _ as also gastrotomy.

OPERATIONS OF GASTROPEXY FOR GASTROPTOSIS

Description.—Gastroptosis signifies a prolapse, or displacement of the stomach from its normal position _ and gastropexy, the technical procedure whereby it is fixed, by suture, to some more fixed point of support. The special method of suturing is usually the chief feature of the particular operation. The problem of gastroptosis is frequently difficult, in that the stomach may not alone be at fault, but only one of a number of prolapsed viscera _ forming only a part of a general visceroptosis.

Rovsing describes two types of gastroptosis, _ one occurring in young unmarried women, with firm abdomens, who offer the best subjects for operation, _ and the other, in multiparous women with relaxed abdominal walls, and in whom other viscera are also apt to be displaced, in whom the various forms of abdominal support and rest in bed are often helpful, and in whom operation is more of a problem. While all the intra-abdominal viscera may share in the prolapse, those which are most apt to be involved are the stomach, liver, and transverse colon.

Several methods of procedure have been devised _ some consisting of direct stomach fixation _ others, of stomach suspension. Those most frequently employed will be considered.

Preparation _ Position _ Landmarks _ Incision.—As for median abdominal section.

Operation.—The approach is generally by median section. The stomach and its surroundings are carefully examined _ as well as the condition of other viscera which frequently share in the prolapse.

Gastropexy, by Suspension, Through Shortening the Lesser Omentum.—Beyea's Operation (Fig. 3465): _ The field of operation is approached through a 7.5 to 10 cm. (3–4 inches) incision in the median line, exposing the cardia, lesser curvature, part of the left lobe of the liver, and the gastrohepatic and gastrosplenic ligaments. The patient is put in the Trendelenburg position and the stomach displaced downward, better exposing the lesser omentum. The liver is protected with gauze and retracted upward. The lesser omentum is now pleated, or plicated by three rows of sutures, placed as follows: _ The first row of five or six interrupted mattress-sutures begins in the gastrophrenic ligament, and stretches across the gastrohepatic ligament, nearly to the pyloric orifice and hepatoduodenal ligament _ forming a plication in the center of the lesser omentum of about 4 cm. ($1\frac{9}{16}$ inches) vertically, and including enough of the delicate tissue (about 1 cm., or $\frac{7}{16}$ inch) not to tear out _ the sutures being about 2.5 cm. (1 inch) apart, and caught in hemostats after passage. The second tier is similar to the first, but 2.5 cm. (1 inch) above it, approximating the lesser omentum from above and behind the first tier, with the lesser omentum below and in front of it. The third tier approximates the lesser omentum just above the gastric vessels, with the lesser omentum a short distance below the diaphragm and liver. The sutures pass through the normal ligamentary supports _ and the distance between the rows increases from left to right, with the increase of the vertical stretch of the ligament. The sutures are of chromic gut _ and all are placed and clamped before any are tied _ and then the tiers are tied in the order in which they were placed _ and after all packings and retractors are removed, or so shifted as to enable the stomach to be brought up even a little above the normal, especially its pyloric end. The gastrohepatic ligament may be very frail in its center, requiring careful manipulation in the placing of the sutures. This is probably the best form of gastropexy, where the lesser omentum is sufficiently substantial to stand the suturing and counterpull.

Gastropexy by Suspension in a Hammock of the Great Omentum.—Coffey's Operation (Fig. 3466): _ The stomach is exposed by a median epigastric incision, 12.5 to 15 cm. (5–6 inches) in length. The stomach is exposed, freed of all adhesions, and placed in its normal position. The details of the operation will depend upon the degree of ptosis, and whether it be of the stomach alone or associated with other ptoses. The gastrocolic omentum is sutured transversely to the anterior abdominal wall by six to ten interrupted chromic gut sutures (according to the extent of the condition) _ the sutures, about 2.5 cm. (1 inch) apart, and about the same distance below the stomach, extending toward the cardiac end as far as possible _ thus forming a hammock in which the stomach is supported. Sometimes the great omentum is picked up both below as well as above the transverse colon _ the two tiers of suturing thus forming a broad width of great omentum, about 6.5 cm. (2½ inches) above the umbilicus, to adhere to the abdominal wall. The second row of sutures is especially indicated when the transverse colon is also prolapsed. Coffey also shortens the gastrohepatic ligament in the same manner that Beyea does, in addition to the technic upon the greater omentum. If hepatosis be present, he also shortens the falciform ligament. The particular reason for extending the sutures as far to the left as possible, parallel with the greater curvature, is to prevent the subsequent tendency of the stomach to sag toward the left.

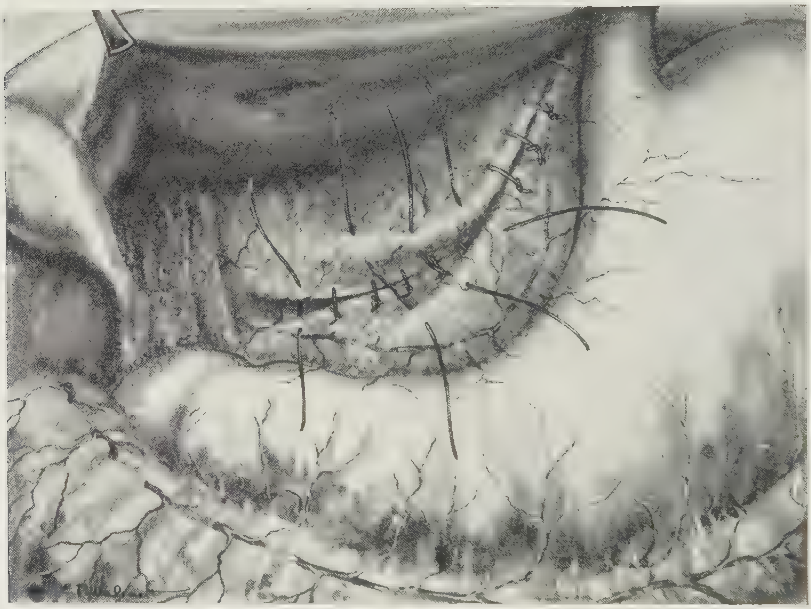


Fig. 3465.—Gastropexy, by Suspension, Through Shortening the Lesser Omentum _ Beyea's operation.

The combination of the Beyea and Coffey technics makes an especially good procedure.

Gastropexy by Direct Suture of the Stomach to the Anterior Abdominal Wall.—Rovsing's Operation (Fig. 3467): _ The stomach is here supported by three sutures which pass through its outer walls and then through the entire thickness of the abdominal wall. Rovsing's own description follows: _ "Parallel with the lesser curvature I lead three strong silk threads in and out through the serous coating of the anterior surface of the stomach, leaving the pyloric portion free. The upper thread is placed close to the lesser curvature, and the two others with an interval of about 2 cm., are placed in such a way that the greater curvature and a rather large piece of the wall above this are left free. With a fine needle the serous coating between the threads is now scarified in all directions, also the surface of the parietal peritoneum, and eventually that part of the under surface of the liver to which one wishes the stomach to adhere. The ends of the silk threads are led out through the entire thickness of the abdominal wall; that on the left, as far as the site of the rib curvature; that on the right, about 3 cm. to the right of the center line. The peritoneum is now joined with catgut, and the fascia and skin with aluminum-bronze, and after the line of the wound has been closed with collodion and cotton wool, the silk sutures are tied over a glass plate covered with sterile gauze, the dimensions of which are a little larger than the stomach-surface which has to be fixed. The silk threads are left for four weeks, and are then easily removed." Rovsing states that by the time the sutures are removed, the stomach has solidly united with the abdominal wall. He also shortens the gastrocolic ligament to correct the accompanying coloptosis.

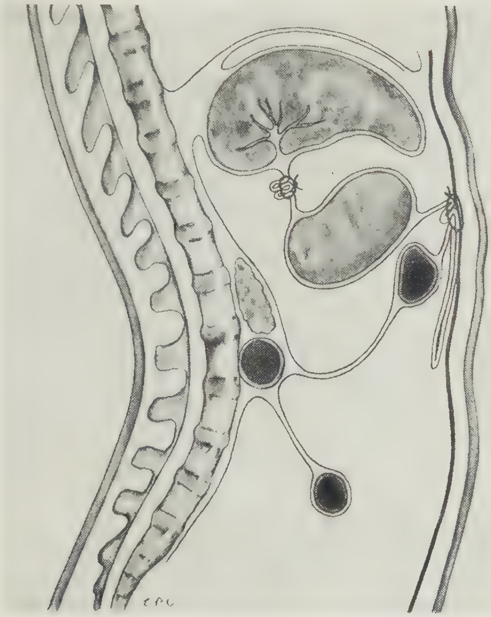


Fig. 3466.—Gastropexy by Suspension of the Stomach in an Omental Hammock _ Coffey's Operation; _ The gastrohepatic omentum has been shortened by pleating _ and the stomach and transverse colon are further suspended, anteriorly, by pleating and suturing the gastrocolic and great omentum to the anterior abdominal wall.

Gastropexy by Direct Suture of the Stomach to the Anterior Abdominal Wall.—Duret's Operation (Fig. 3468): – The feature of this, the first form of gastropexy to be adopted, is the passage of a continuous suture through the serous and muscular coats of the anterior wall of the stomach, on the one hand, and through the undivided parietal peritoneum on a level with the fold around the round ligament of the liver, on the other. The stomach is exposed by a median abdominal section, from the xiphoid cartilage to the navel. The incision exposes the posterior rectal sheath and peritoneum in its entire length. The posterior sheath of the rectus and the peritoneum are then opened at the lower end of the wound, and to a limited extent only – sufficiently to enable the stomach to be manipulated during the rest of the operation. The anterior aspect of the peritoneum is bared by the lateral retraction of the recti. With a continuous silk suture the anterior stomach wall is fixed to the undivided portion of the peritoneum in the upper aspect of the wound. The suture, beginning on the patient's left, passes, from without inward, through the fascia, retracted margin of the rectus muscle, and peritoneum – thence horizontally through the serosa and muscularis of the stomach. The needle is now passed upward and penetrates the upper, uncut peritoneum from within outward – passes horizontally to the right – and again penetrates the peritoneum, but from without inward – passing downward to the stomach – where the suture of its wall is repeated – and so on to the pyloric end of the stomach – the needle finally making its exit through the right edge of the rectus. When this suture is drawn tightly and tied (as a buried suture between rectal sheath

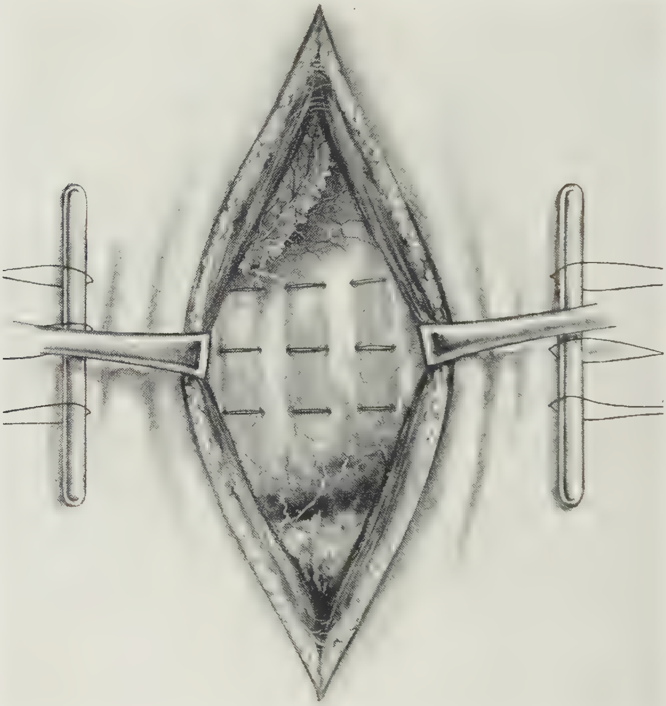


Fig. 3467.—Gastropexy by Direct Suture of the Stomach to the Anterior Abdominal Wall – Rovsing's operation.

and fascia) the lesser curvature of the stomach is drawn upward and fixed. The sutures have the effect of a series of mattress-stitches placed about 2 cm. ($\frac{3}{4}$ inch) apart. Moynihan suggests that chromic catgut, or kangaroo-tendon be employed instead of silk. The abdomen is closed as usual.

Davis performed a somewhat similar operation – but sutured the portion of the lesser omentum just above the stomach, to the parietal peritoneum above. In some cases this was accompanied by gastroplication.

Treves, in whose case the liver was also involved, passed three stout silk sutures – one, through the edge of the liver, to the round ligament – and two, from the falciform ligament and round ligament, to the fibrous tissue of the abdominal parietes, near the ensiform cartilage.

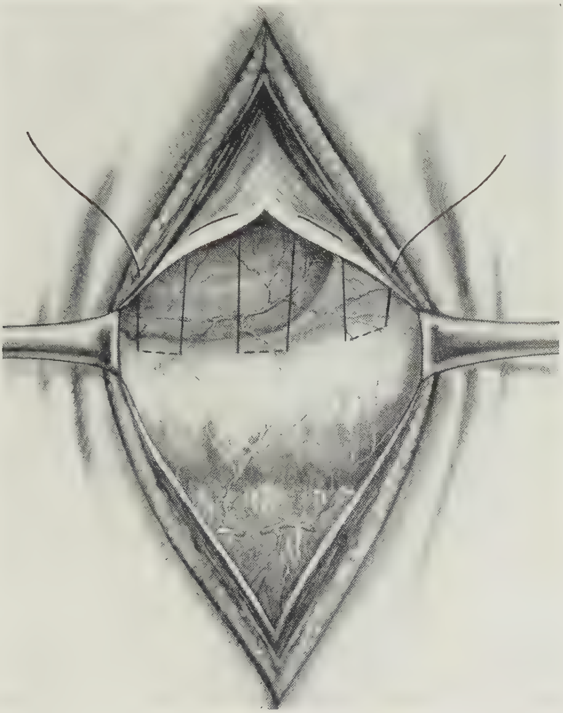
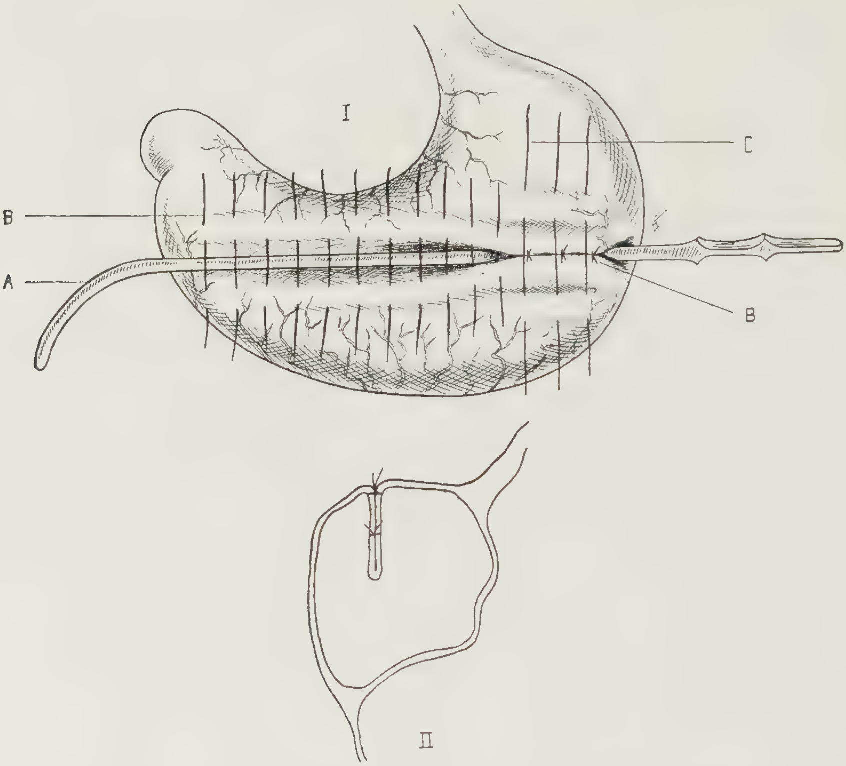


Fig. 3468.—Gastropexy by Direct Suture of the Stomach to the Anterior Parietal Peritoneum and Abdominal Wall – Duret's operation.

OPERATIONS FOR DIMINISHING THE SIZE OF THE ENLARGED STOMACH

Description.—In-folding of the anterior stomach wall has been resorted to occasionally, in so-called idiopathic, atonic, or atrophic dilatation of the stomach – in which the dilatation is due to no form of obstruction to its outflow. Indications for its employment probably will be but rarely found. Several methods of gastroplication, or pleating the anterior wall of the enlarged stomach, have been employed since the original introduction of the method by Bircher in 1890. The operation is sometimes less happily termed "gastrorrhaphy." The stomach is exposed in the usual manner – either through a right paramedian or median abdominal section.

Gastroplication by Bircher's Method.—Consists of doubling practically all of the anterior stomach wall upon itself, from below upward, carrying the great omentum upward with it. A point toward the pyloric end of the greater curvature is sutured to a point toward the pyloric end of the lesser curvature – and a point toward the cardiac end of the greater curvature, is sutured to a point high up upon the fundus of the stomach – the anterior stomach wall folding forward and upward in consequence. The great omentum is carried upward with the lifted greater curvature. No sutures are used except at the two points mentioned. The sutures pass through serosa and muscularis only – and are usually of silk or linen, but may be of chromic catgut.



Figs. 3469 and 3470.—Gastroplication (Weir's Modification of Bircher's Operation) – :I A, Sound infolding anterior stomach wall; B, B, first tier of Lembert sutures burying in sound; C, second tier of sutures ready to bury in sound for second time, when latter is placed upon first tier. II, Sectional view of stomach after the two tiers have been tied.

Gastroplication by Weir's Modification of Bircher's Method.—Consists in the reduction of the size of the enlarged stomach by invaginating a fold of the anterior stomach wall inward upon itself by two or more tiers of superimposed sutures. The anterior wall of the stomach is exposed and lifted as far forward into the wound as possible, separating by blunt dissection all minor adhesions. In a direction parallel with the long axis of the stomach and midway between the greater and lesser curvatures, depression of the anterior surface of the stomach is made with a sound, causing parallel longitudinal ridges to form on either side of the sound (Figs. 3469, 3470). These ridges of anterior stomach wall are now united with interrupted silk sutures, passing through serous and muscular coats of each ridge, and extending for 15 to 20 cm. (6–8 inches). The sound is now withdrawn and reapplied over the first line of sutures, and parallel with it — similarly depressing them — and similarly causing two secondary parallel longitudinal folds of anterior stomach wall to rise up on each side of the sound. These secondary folds are similarly sutured. Whether a third tier is placed will depend upon the size of the stomach — the process being continued, in some cases, until the greater and lesser curvatures meet. The stomach is then allowed to recede into position — and the abdomen is closed. The completed operation is seen in Fig. 3471.

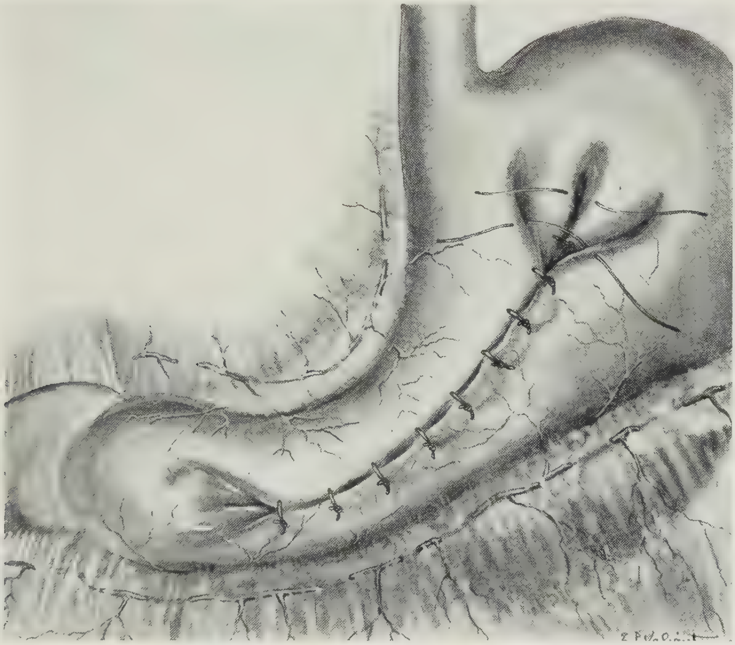
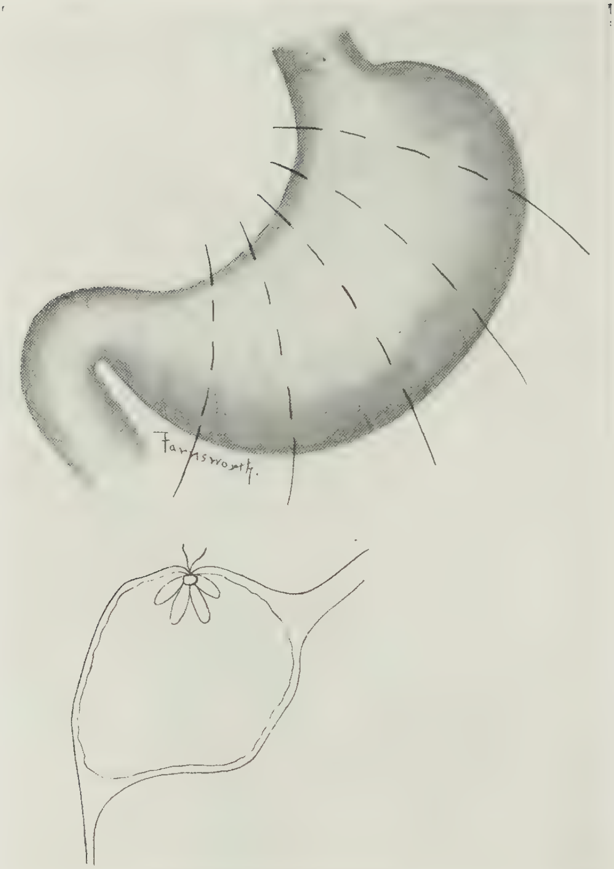


Fig. 3471.—Gastroplication by Weir's Modification of the Bircher Method — The completed operation.

Bircher did not suture the two walls of the fold together, but left a dead space — Weir's suturing of these folds into apposition constitutes his modification. Chromic gut may be substituted for silk.

Gastroplication by Moynihan's Modification of Bircher's Method.—The in-folding of the anterior stomach wall is here accomplished by a different application of the sutures.

Having exposed the stomach, a series of vertical, interrupted, seromuscular sutures are placed in its anterior wall — as illustrated in Fig. 3472. Each stitch passes into the wall of the stomach several times — and when these are drawn tight and tied, the wall of the stomach is folded into as many plaits or ridges as there are bites in each suture — as shown in Fig. 3472, the plaitings projecting into the interior of the organ. A posterior gastro-enterostomy is done in completing the operation.



Figs. 3472 and 3473 —GASTROPLICATION (MOYNIHAN'S MODIFICATION OF BIRCHER'S OPERATION): — I, — Interrupted plaiting sutures in anterior wall of stomach; II, — Cross-section of stomach, showing the result of tightening and tying these sutures.

OPERATIONS FOR THE DILATATION OF THE PYLORIC ORIFICE OF THE STOMACH

These procedures aim to overcome the stenosis of the pylorus through methods of stretching — under the technical term of pylorodiosis. The method has been used for both organic and spasmodic contractions — its greater scope being in the latter category of cases, and in simple hypertrophy — and should not be used in stenosis due to scar-tissue.

Temporary good usually results — but the condition is apt to recur — especially when the stenosis is organic. Some element of danger is also present in these methods — the duodenum having been ruptured. The procedures, therefore, have been largely replaced by other measures.

The dilatation of the narrowed pylorus is carried on either after the opening of the stomach (Loreta) — or through the unopened stomach (Hahn). The stomach is exposed through either a median, or right paramedian abdominal section.

Pylorodiosis by Loreta's Technic.—The cavity of the stomach is entered by gastrotomy, after which the constricted pyloric orifice is dilated. Originally the dilatation was done by one or more fingers, but subsequently instrumental dilatation was often employed.

Abdominal section is done, the abdominal wound retracted, and the pyloric end of the stomach isolated and brought as far into the wound as possible, the surroundings being protected by gauze-packings. Incise the anterior stomach wall vertically, at a distance of about 5 cm. (2 inches) from the pylorus, and midway between the upper and lower curvatures, at first, to an extent only sufficient to admit the index-finger snugly. The right index-finger is immediately inserted through the opening and is made to slowly work its way through the pyloric stricture, while the region is steadied from without by the left hand. Should the stricture be found too tight for the tip of the finger, a dilating instrument may be used first, to be followed by the finger. When the stricture is enlarged sufficiently to accommodate one finger, the stomach wound is increased with a blunt bistoury, without withdrawing the first finger, and the middle finger introduced alongside of it. The fingers in the stomach wound prevent any considerable hemorrhage, the vertical direction of the gastric incision also aiding in this respect. Even a third finger may be introduced. Instead of digital dilatation, instrumental dilatation has been more employed latterly than formerly, using such instruments as graduated bougies and uterine dilators (Fig. 3474). It is to be remembered that there is greater danger of damage to the structures in using instruments, rather than fingers. During the stretching, whether digital or instrumental, the pyloric end of the stomach is steadied by the fingers of the left hand. The dilatation is carried on until the pyloric orifice has been stretched slightly in excess of the normal. If the mucosa is torn during the process of stretching, which is more apt to occur with instruments, the bleeding is usually difficult to control. Having accomplished the degree of dilatation sought, the fingers, or instruments, are

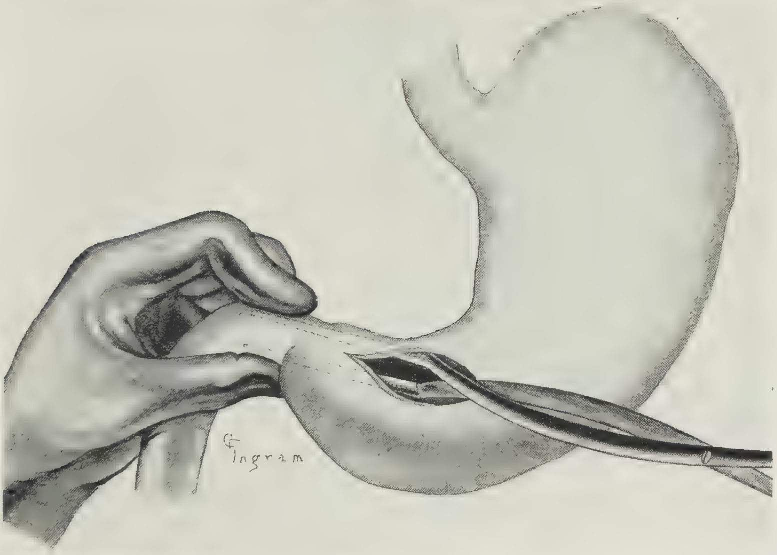


Fig. 3474.—Instrumental Dilatation of the Contracted Pyloric Orifice Through a Gastrotomy Wound.

withdrawn _ and the hemorrhage from the margins of the gastric wound controlled by twisting, or ligating the severed vessels, the stomach wound is closed by a double tier of sutures _ and the abdomen in the usual way.

The incision made through the stomach at a right angle to the long axis of the pylorus (that is, the vertical incision of the stomach wall), both pass through a less vascular wall, and affords, by retraction, easier exposure of the pylorus, than does an incision in the axis of the pylorus, as is sometimes used. Loreta has varied the method of dilatation by inserting two fingers into the pylorus, after which he bent them and practised traction in opposite directions.

Pylorodiosis by Hahn's Technic.—In this procedure no opening is made in the stomach _ the adjacent anterior stomach wall being simply invaginated into the pylorus, upon the end of the gloved finger. The cavity of the stomach thus escapes invasion _ which is the chief feature of the operation.

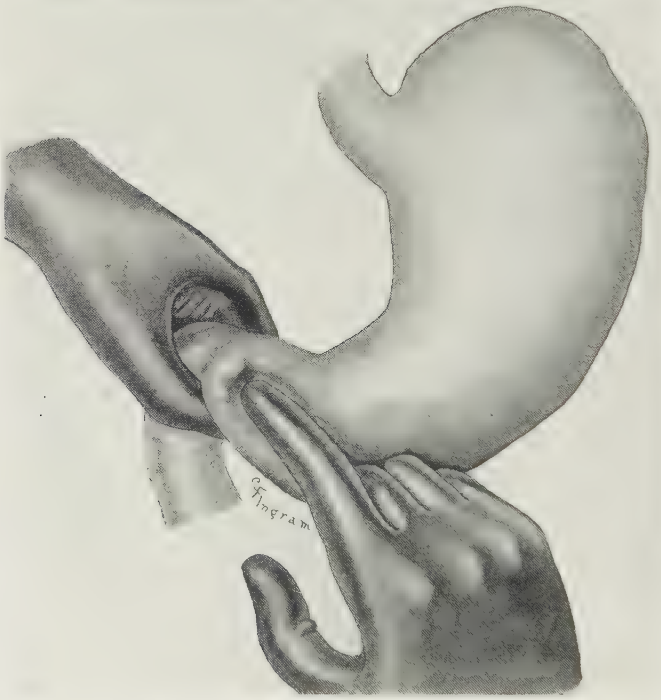


Fig. 3475.—Pylorodiosis by Hahn's Technic.

Having brought the pyloric aspect of the stomach well into the field, the Surgeon seizes the pyloroduodenal region with his right fingers _ for the steadying of this part is an absolute prerequisite to the rest of the technic _ as, without the counterpressure thus offered, the right index-finger can make little headway in its boring-in process, which requires some pressure on the part of the advancing finger, and some resistance on the part of the steadying hand. It is particularly desirable to find a relaxed stomach wall, as it is hard to make progress against one thrown into spasm. While steadying the pyloric orifice with the right fingers, the left index-finger invaginates the anterior stomach wall toward, and into, the pyloric orifice, until the tip of the gloved finger engages itself in the pyloric opening _ as shown in Fig. 3475. Sometimes, owing to spasm of the parts in the immediate neighborhood of the pylorus, the finger must begin its invagination further away. Occasionally the dilatation must be begun with the little finger. If an ungloved finger were used, traumatism to the stomach wall might occur. By steady pressure of the advancing finger even a contracted pylorus is usually entered with a small finger _ which may be immediately replaced by a larger finger. The aim should be to introduce two fingers simultaneously _ which represents about the right degree of dilatation. Upon the completion of the stretching, the abdomen is closed in the usual manner.

Pylorodiosis for Congenital Pyloric Stenosis by Rammstedt's Technic.—Formerly gastro-enterostomy was the surgical procedure usually resorted to for this condition. In Rammstedt's technic, which was introduced in 1913, and has been successfully applied in a considerable number of cases since, a longitudinal incision is made in the thickened and indurated pylorus, and carried through the serosa and muscularis _ down to, but not through, the mucosa. This division of the muscular ring makes possible the re-establishment of the lumen of the pylorus _ generally with relief of the obstructive symptoms. Quoting from Lewisohn, Downes, in 67 operated cases, had a mortality of 24 per cent. _ Lewis, in 18 cases, 17 per cent. _ and Robertson, in 16 cases, 31 per cent. Comparing this with the results of gastro-enterostomy, Scudder, in 17 operated cases, had a mortality of 17 per cent. _ Stillman, in 10 cases, 10 per cent. _ and Richeter, in 19 cases, 10 per cent.

The chief danger in the operation is in inadvertently incising the mucosa _ which is best avoided, after incising the serosa and the superficial part of the thickened muscularis, by making a blunt division of the rest of the muscularis _ carefully stopping short of dividing the mucosa (a technical procedure requiring extreme care, especially in a child). If an opening of the mucosa be made, it has been suggested to close it with a piece of omentum. It is said that if the axial incision is just a little short of dividing the entire length of the thickened area, a cure will not follow _ and that if the incision be made only 1 millimeter too long on the duodenal side, there will be grave danger of opening up the duodenum (which is particularly thin in these cases). In other words, as Lewisohn remarks, the margin between what should be done, and what should be avoided, is exceedingly small.

OPERATIONS FOR THE DILATATION OF THE CARDIAC ORIFICE OF THE STOMACH

The usual method formerly in vogue for the treatment of cardiospasm was the dilatation of the cardiac orifice through a temporary gastrostomy wound, by means of graded sounds, by finger, and by dilators. This has been largely replaced by dilating instruments introduced through the mouth _ which is now the accepted method _ and operation the alternative, when the oral route cannot be used.

Gottstein devised a spindle-shaped, silk-covered rubber bulb, with constricted center _ which is introduced through the mouth and dilated with water _ the isthmus of the bulb being grasped by the constriction, so that it is kept from slipping into either the esophagus above or the stomach below. This form of dilator is shown, diagrammatically, in Fig. 3476.

Expanding metallic dilators, such as the Lerche dilator for cardiac constriction, introduced per oram, are also employed.

Heller has devised an operative technic which he has successfully carried out. After exposing the cardiac end of the esophagus by blunt dissection, he made two longitudinal incisions across the cardia, anteriorly and posteriorly, through serosa and muscularis _ without opening the mucosa.

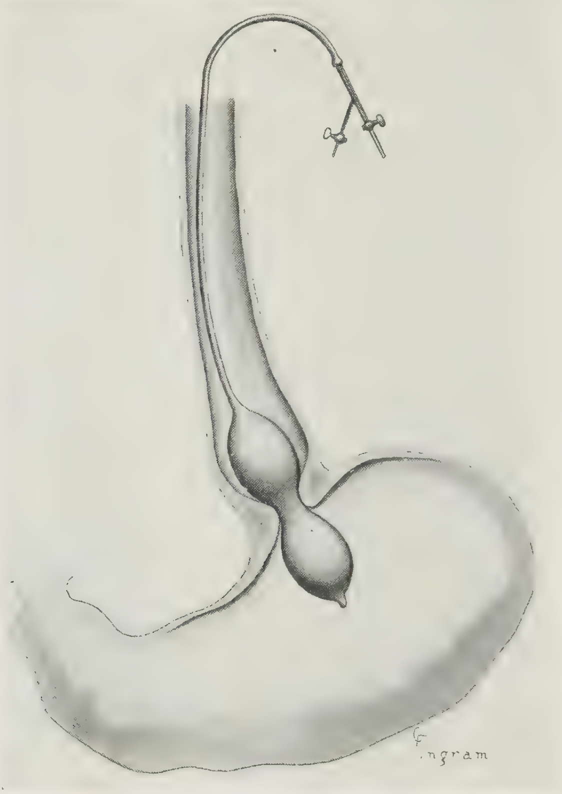


Fig. 3476.—Gottstein's Spindle-shaped, Silk-covered Rubber Bulb Dilated with Water, for use in cardiac constriction.

Heyrovsky applied to the cardia the method of Finney's pyloroplasty, satisfactorily accomplishing the object in the case undertaken, although the technic is much more complicated than in the pyloric operation.

GASTROSTOMY, IN GENERAL

Description.—By gastrostomy is meant the establishment of a more or less permanent fistulous opening in some part of the anterior wall of the stomach, for the purpose of alimentation, or surgical treatment, the stomach generally being attached by suture to the anterior abdominal wall, just preceding or following the incision of its wall.

Formerly, where no emergency existed, and where the stomach was entered by a simple opening, the operation was often performed in two stages, the stomach first being attached to the opening in the anterior abdominal wall, and, after three to five days were given for union to shut off the peritoneal cavity, the stomach was incised. Now the opening into the stomach is usually made in a somewhat more complicated manner to secure better control, and the nature of some of these modern openings generally requires that they be made at the time of the abdominal section.

The opening is meant to be more or less permanent, according to the purpose for which it is made. Where the operation is performed for inoperable gastric carcinoma, the gastrostomy is intended to be permanent. Where the operation is carried out for some temporary purpose, as for treating an esophageal stricture, the fistula is expected to subsequently heal of its own accord, which is generally the case ‒ or a special operation may be later performed for its closure.

Indications.—The chief indications for the performance of gastrostomy occur in cases in which there is obstruction of the esophagus, or at the cardiac end of the stomach, interfering with the comfortable passage of sufficient nutrition for the patient.

Object of the Operation.—The establishment of a gastric fistula, leading from the mucosa of the stomach to the skin of the abdomen ‒ through which a tube can be passed, along which food is introduced into the stomach.

Preparation of the Patient.—In cases where it is feasible, the stomach should be lavaged upon several days preceding operation, and just prior to operation (v. p. 237). The site of operation is shaved. The bowels are emptied.

Anesthesia ‒ Analgesia.—The operation is usually performed under analgesia in persons of good condition. The operation, as a palliative measure, is often called for in emaciated individuals, who are often unfit persons for the additional strain of anesthesia, and in these individuals analgesia is often indicated, and may be conveniently employed, as the operation is, as a rule, rather a simple and a brief one.

Position During Operation.—Supine, at the side of table, with abdominal parietes relaxed by slight elevation of the shoulders and slight flexion of the hips; Surgeon to right in operating in median line, and to left in the subcostal operation; Assistant opposite.

Division of Abdominal Parietes.—Muscles should be divided in their cleavage line, in so far as this is possible ‒ and the abdominal nerves should be spared as far as practicable. A disadvantage of all oblique incisions parallel with and just below the left costal arch is the difficulty of making an intramuscular separation of the fibers. Considerable differences of statement exist among the writings of Surgeons as to the placing of the skin incision, and as to the manner of dividing, dealing with, and suturing the subjacent structures in the descriptions of even the same operation of Gastrostomy.

Form of Artificial Canal.—As to regurgitation of stomach contents, the longer, more indirect, and more valvular the canal between the stomach and abdominal openings, the greater the control over the gastric contents. Immediately after operation, rubber tubes for feeding are passed down the artificial fistula ‒ but after the first few days these tubes are introduced only at times of feeding ‒ while in some cases the tubes must be constantly worn, only being removed for cleansing.

Comparison of Methods.—There are two general types of gastrostomies, which more or less merge into each other, in the principles of their action. One is more particularly characterized by the formation, out of the stomach wall, of artificial valve-like openings between stomach cavity and skin surface ‒ such as the methods of Witzel, Stamm (or Senn), Kader, and others. In the other type, the formation of a more or less tortuous canal is resorted to ‒ as in the Witzel, Ssabanajew-Franck, Marwedel, and others. In both, more or less use is made of the constricting effect of variously displaced parts of the left rectus muscle.

The two methods probably most frequently employed are Witzel's and Stamm's.

GASTROSTOMY

BY WITZEL'S METHOD

Description.—The stomach is approached by an oblique incision below the left costal arch, passing through skin and fascia _ with vertical incision of the anterior rectal sheath and separation of the fibers of the rectus in their cleavage line _ vertical division of the posterior layer of the rectal sheath _ and division of the peritoneum. A rubber tube is then buried in a long, oblique canal in the anterior stomach wall, formed by a process of suturing _ following which the stomach wall is sutured to the parietal peritoneum and edges of the posterior layer of the rectal sheath _ and the abdominal wound closed over all, up to the exit of the tube.

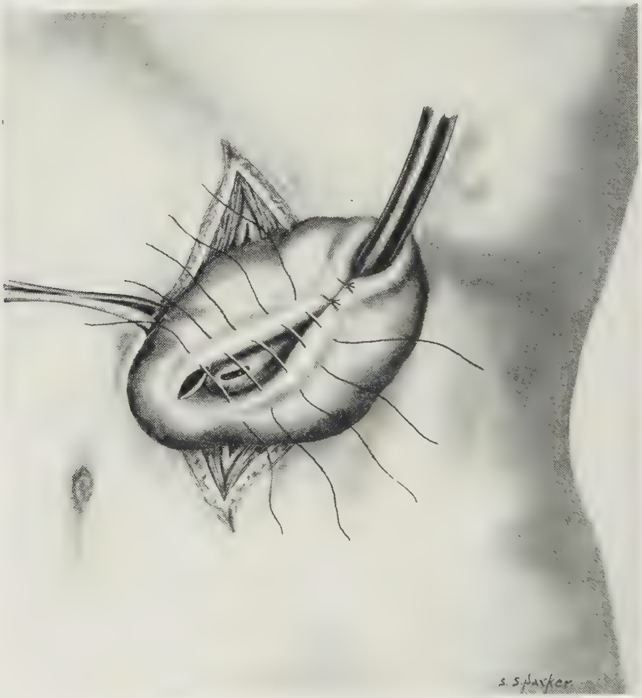


Fig. 3477.—The Witzel Method of Gastrostomy _ I; _ The stomach has been delivered through the vertically split fibers of the left rectus muscle _ and the tube has been partly buried in its anterior wall by suturing _ its end being ready to insert into the cavity of the organ through the stab-wound _ after which the remaining sutures will be tied.

Preparation _ Position.—See General Surgical Considerations.

Landmarks.—Median line; linea semilunaris; left costal arch.

Incision.—Oblique, parallel with and 2.5 to 4 cm. (1–1½ inches) from the left costal arch _ beginning near the median line and passing downward and outward for about 7.5 cm. (3 inches) _ or placed more vertically.

Operation.—Incise skin and fascia in the above line _ clamp vessels _ and retract lips of wound. Expose the rectus muscle _ divide the anterior layer of its sheath vertically _ and separate the fibers of the rectus muscle in their cleavage line by blunt dissection. Similarly incise the posterior layer of the rectal sheath. Divide the transversalis fascia, subserous areolar tissue, and peritoneum in the same line.

Retract the parts well _ and draw the portion of the anterior stomach wall which is to be dealt with well into the wound. A velvet-eyed rubber tube is now laid against the anterior wall of the stomach, generally in such a position as to correspond with the outer wound, with the blunt end of the tube toward the greater curvature of the stomach and the opposite end directed toward the lesser curvature. About 5 to 7.5 cm. (2–3 inches) of this tube is now buried in the anterior stomach wall by Lembert gut sutures, placed about 5 mm. ($\frac{3}{16}$ inch) apart, and extending at least 1.3 cm. ($\frac{1}{2}$ inch) beyond the point at which the tube is to enter the stomach, and so placed as to avoid the larger vessels. All the sutures are now tied, thus burying in the tube _ except the three or four at the lower end of the tube.

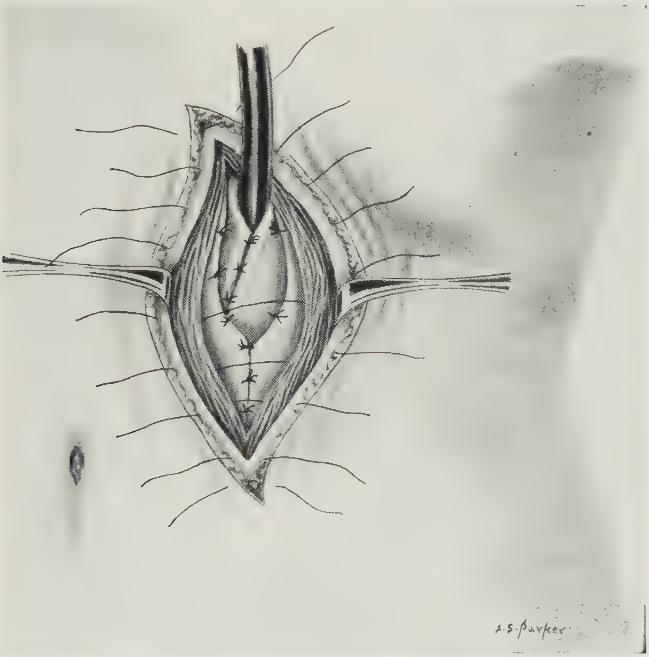


Fig. 3478.—The Same _ II; _ The stomach, outlying the region of the infolded tube, is sutured, through its serosa and muscularis, to the parietal peritoneum, subserous areolar tissue, transversalis fascia, and posterior layer of the rectal sheath. The split rectus and corresponding portions of its anterior sheath are being sutured together _ after which the skin wound will be closed up to the tube.

The stomach wall is then held in such a way as to render the site of entrance of the tube into the stomach prominent, and, at the same time, so as to separate the opposite (posterior) stomach wall _ and with a narrow, sharp-pointed bistoury, a quick, controlled stab is made through all the layers of the anterior stomach wall, guarding against wounding the opposite (posterior) wall _ the opening being made just beneath the tip of the tube, which is temporarily withdrawn about 6mm. ($\frac{1}{4}$ inch) for that purpose and just before the stab is made. Immediately upon the completion of the stab-wound, which should be a little less in extent than the caliber of the tube, the end of the tube is thrust through the opening and into the cavity of the stomach (Fig. 3477) _ and the already placed sutures, which were temporarily left untied at the lower end of the tube, are at once tied _ thereby preventing any regurgitation of the stomach contents.

The stomach is now allowed to fall back into the abdominal cavity sufficiently to leave only the site of the anterior stomach wall represented by the buried tube in contact with the edges of the abdominal wound _ and even this area is so adjusted as to cause the site of the buried tube to be surrounded by the edges of the abdominal wound in the form of as small an ellipse as possible. Finally, the serous and muscular coats of the stomach are now united by interrupted gut sutures to the parietal peritoneum and lower lip of wound along this narrow ellipse (Fig. 3478). The edges of the abdominal wound are then closed _ first with chromic gut interrupted sutures passing through the entire thickness of the opposite lips of the separated rectus muscle, together with the edges of its sheath, but not involving the already sutured peritoneum, _ followed by interrupted or continuous silk suturing of the skin and fascia. The rubber tube will emerge between the two or three upper sutures. The rubber tubing is held in position by a silk suture passing through the outer part of its wall and attached to the skin. The tube is left in for three or four days _ and then inserted only for feeding. A sectional view of the tube *in situ* is shown in Fig. 3479.

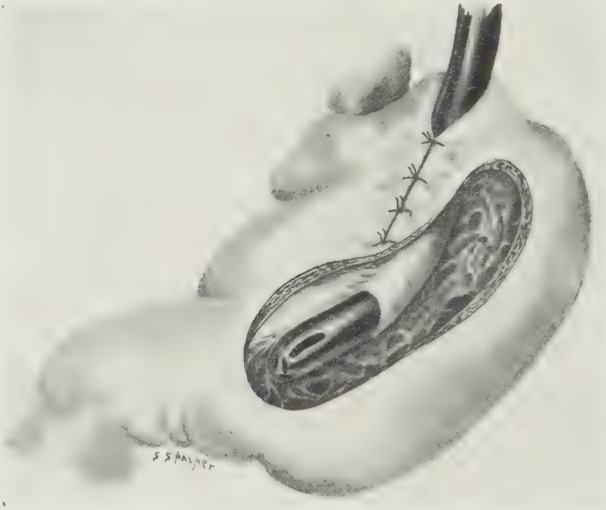


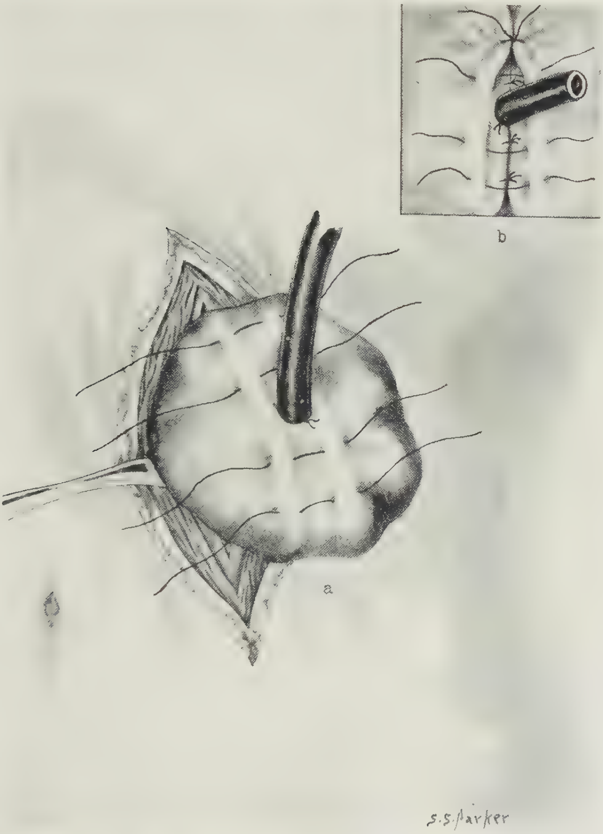
Fig. 3479.—The Same _ III; _ SECTIONAL VIEW OF THE WITZEL GASTROSTOMY _ the inner end of the tube is seen projecting, free, into the cavity of the stomach _ while the portion next beyond is shown buried in the overfolded and sutured anterior stomach wall _ while the portion still further beyond projects out into the open.

Comment.—(**1**) The site of incision sometimes differs from that above given _ and the fibers of the rectus are sometimes cut instead of separated _ but all muscular structures should be separated, and nerves retracted, as far as these may be done. (**2**) Fenger's incision is sometimes used _ about 7.5 cm. (3 inches) in length and placed to the left of the rectus, and 2.5 cm. (1 inch) from and parallel with the left costal arch. (**3**) Before the stomach is dropped back into the abdomen, three gut sutures may be inserted through its serous and muscular coats, each threaded with a needle at either end _ and after the stomach has receded into its normal position these needles are made to pierce the edges of the abdominal wound, from within _ and the stomach thus drawn up to the edges of the abdominal opening. (**4**) By postponing the opening into the stomach until all the sutures are placed and most are tied, the leakage is minimized. (5) Regurgitation is prevented by the constriction of the separated fibers of the rectus _ by the long, oblique canal _ and by the short artificial cone created by the manner of suturing, and which projects into the stomach. (6) Operators differ as to the direction in which they divide the layers of the rectal sheath and subjacent structures.

GASTROSTOMY

BY KADER'S METHOD

Description.—This is a modification of Witzel's operation, and, at the same time similar, in principle, to Senn's operation. It consists in the insertion of a tube into the stomach at a right angle to its surface _ and, by means of two tiers of Lembert interrupted sutures, two parallel folds are made in the anterior stomach wall, thus invaginating the stomach wall and burying in the tube. The stomach is reached through the vertically separated fibers of the rectus.



Figs. 3480 and 3481.—Kader's Method of Gastrostomy _ I; _ The tube has been introduced through the anterior wall of the stomach, into its cavity _ and is being buried in by two parallel ridges of stomach wall. In **a**, the first tier of Lemberts is being placed through serosa and muscularis, _ and, in **b**, the second tier, burying in both tube and first tier. The end sutures of the second tier are left long, as tractors to aid in subsequent manipulations.

Preparation _ Position.—See General Surgical Considerations.

Landmarks.—Linea alba; linea semilunaris; left costal arch.

Incision.—Vertical incision over the left rectus muscle, beginning about 2.5 cm. (1 inch) below the costal cartilages and extending downward 6 to 7.5 cm. ($2\frac{1}{2}$–3 inches).

Operation.—Incise skin and fascia in the above line _ clamp bleeding vessels _ retract margins of the wound, exposing the sheath of the rectus. Divide the outer sheath of the rectus vertically. Separate the fibers of the rectus by blunt dissection in their cleavage line. Divide vertically the posterior sheath of the rectus, transversalis fascia, subserous areolar tissue, and peritoneum. Isolate and draw into the wound a fold of the anterior stomach wall _ packing off the peritoneal cavity with gauze.

Having selected an appropriate site, and while the stomach is properly held by an assistant so as to avoid injury to the opposite (posterior) wall, an opening somewhat smaller than the caliber of the tube is made by a quick, controlled stab with a narrow, sharp-pointed bistoury. Having seen that no serious hemorrhage follows the stab-wound, a rubber tube is immediately inserted into the stomach cavity through this opening and sutured to the edge of the stomach wound with two gut sutures passing into but not through the wall of the tube. While the tube is held perpendicular to the stomach wall at its point of entrance, two chromic gut Lembert sutures, about 1.2 cm. ($\frac{1}{2}$ inch) apart, are so passed through the serous and muscular coats of the stomach, on either side of the tube, as to raise a fold or pleat of stomach wall about 7.5 cm. (3 inches) long and 1.2 cm. ($\frac{1}{2}$ inch) high (Figs. 3480, 3481). These deep occlusion sutures are then tied _ the included tissues infolding into the stomach in the form of a funnel-shaped projection. A second tier, superficial occlusion sutures, is similarly placed, at the same distances apart, above the first, which are, in turn, thus buried in by the second, forming a second fold. The sutures of the second tier are temporarily left long, to aid in the subsequent manipulation of the stomach. The tube may be buried by means of two or more tiers of purse-string sutures.

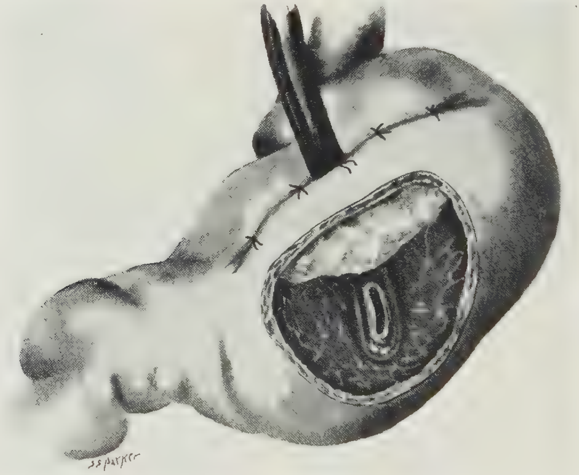


Fig. 3482.—The Same _ II; _ Sectional view of the implanted and buried tube.

The general peritoneal cavity is shut off by stitching the serous and muscular coats of the stomach, on the one hand, to the parietal peritoneum and edges of the divided posterior sheath of the rectus; on the other _ holding the stomach by means of the temporarily left occlusion sutures. The separated edges of the rectus are sutured with interrupted chromic gut sutures, which include the anterior sheath of the rectus _ both being closely approximated to the tube. The skin is closed by interrupted silkworm-gut sutures. A sectional view of the result is seen in Fig. 3482.

Comment.—(1) This operation is more generally applicable than Witzel's, of which it is a modification, because of requiring less amount of movable stomach wall _ and because it may be used through any kind of incision exposing the stomach. (2) The folds or pleats are usually made transverse when the opening is to be temporary _ and perpendicular when the opening is to be permanent. (3) Where the stomach is so small, or so bound down, as to make it impossible to bring it well into the wound, the pleating may be made and the tube buried with the stomach *in situ*. (4) The efficiency of the method depends chiefly upon the valvular invagination of the stomach wall. The sides of the infolded funnel soon become adherent, leaving only the tubular tract patulous. (5) As in most gastrostomies, Surgeons vary as to the exact placing of the external incision and the manner of dividing, dealing with, and suturing the subjacent layers. (6) A somewhat similar method (Senn and Stamm) consists in thrusting a tube, through a previously made opening, perpendicularly into the anterior stomach wall _ then surrounding it by a circular purse-string suture about 1.2 cm. ($\frac{1}{2}$ inch) from the catheter, which is then tied, gut being used _ then a second purse-string suture about 2.5 cm. (1 inch) from the first, which is tied similarly _ and a third _ the stomach being attached to the abdominal wall as above.

GASTROSTOMY

BY SSABANAJEW-FRANCK'S METHOD

Description.—A cone of stomach is drawn through the separated left rectus muscle _ carried beneath a bridge-work of skin _ and its apex made to open upon the cutaneous surface just above the left costal arch. The stomach is exposed through an oblique skin incision, approximately parallel with the left costal arch _ with a vertical separation of the fibers of the outer part of the left rectus muscle _ which, at the end of the operation, are sutured about the base of the cone.

Preparation _ Position.—See General Surgical Considerations.

Landmarks.—Median line; linea semilunaris; left costal arch.

Incisions.—Primary incision _ oblique, about 6 to 8 cm. ($2\frac{1}{2}$–3 inches) in length, is made over the outer third of the left rectus muscle, beginning near the median line and passing downward and outward somewhat more vertically than transversely, though approximately parallel with and about 2.5 to 4 cm. (1–$1\frac{1}{2}$ inches) from the left costal arch. Secondary incision (made later in the operation) _ about 2 cm. ($\frac{3}{4}$ inch) in length, is made through the skin and fascia about 2.5 cm. (1 inch) above the costal cartilages and approximately parallel with the original incision.

Operation.—Incise skin and fascia in the above line _ clamping bleeding vessels _ and retracting the lips of the wound. Expose the rectus muscle _ divide the anterior layer of the rectal sheath _ separate the fibers of the outer part of the rectus muscle vertically by blunt dissection in their cleavage line _ divide the posterior layer of the sheath, _ and divide the transversalis fascia, subperitoneal areolar tissue, and peritoneum _ preserving throughout the integrity of the muscles and nerves as much as possible, and retracting the structures as divided (Fig. 3483).

Draw a long cone of the anterior wall of the stomach through the abdominal wound, by means of a silk traction-ligature passing through the serous and muscular coats, or by forceps _ the apex of the cone being represented by a part of the stomach wall nearer the greater than the lesser curvature, and nearer the cardiac than the pyloric end _ calculating that sufficient length of cone be drawn out to pass, without tension, under a bridge-work of skin about 5 cm. (2 inches) wide (Fig. 3483). The serous coat of the stomach forming the base of the cone, is now sutured to the peritoneal and fascial edges of the wound by four gut sutures. The serous and muscular coats of the stomach are then attached throughout to the parietal peritoneum and the posterior layer of the rectal sheath, by interrupted or continuous gut sutures (preferably chromic), avoiding the danger of constriction.

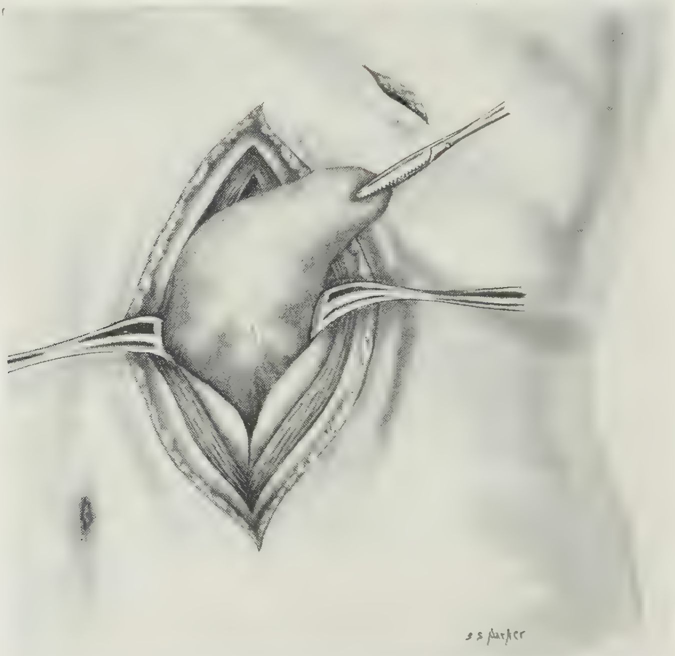


Fig. 3483.—Ssabanajew-Franck's Method of Gastrostomy _ I; _ The cone of presenting portion of stomach has been drawn out of the abdominal wound _ through the incised peritoneum, and between the split fibers of the left rectus muscle _ preparatorily to anchoring the base of the cone to the margins of deeper plane of the abdominal wound _ and drawing the base of the cone over the costal arch and out through an opening in the skin, to the margins of which it will be anchored.

The secondary incision is now made through the skin and fascia in the site indicated (see Incisions) _ passing only into the connective-tissue plane. By blunt dissection from the larger to the smaller wound, the two are connected and the intervening bridge-work of skin thus undermined along the fascial plane. A pair of forceps is passed through the smaller opening into the larger _ grasps the silk traction ligature and draws the cone of the stomach into the smaller, upper wound, over the edge of the lower costal cartilages _ where it is held in place by four silk sutures (Fig. 3484). These four sutures are passed through all the coats of the stomach, on the one side, and through the skin and fascia, on the other _ if the apex of the cone is to be opened at once. But if the opening is to be deferred, the sutures pass through only the serous and muscular coats of the stomach. The small incision is now sutured at either end, leaving a sufficient opening in the center for the passage of the cone. The separated edges of the rectus and its anterior sheath are now sutured with interrupted chromic gut, from either end toward the center, leaving a sufficient opening to guard against dangerous constriction of the base of the cone, while, at the same time, approaching the base nearly enough to form a muscular circle about it. The skin wound is then closed throughout with subcuticular silkworm-gut sutures _ or other form of suturing. The apex of the cone is incised at once in cases of emergency _ otherwise the opening is deferred for two or three days.

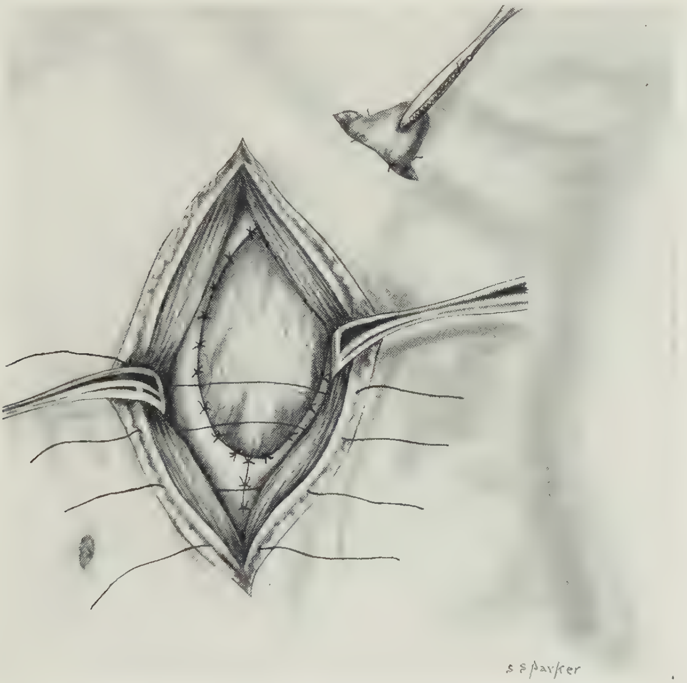


Fig. 3484.—The Ssabanajew-Franck Method of Gastrostomy _ II; _ The cone of stomach has been drawn through the split fibers of the left rectus through the small skin wound above the costal arch, where it is being anchored with sutures. The serosa and muscularis of the stomach is shown sutured, on one hand, to the parietal peritoneum, the subserous areolar tissue, transversalis fascia, and posterior layer of the rectal sheath, on the other thus surrounding the base of the stomach cone. The anterior rectal sheath and the split fibers of the rectus are being sutured together.

Comment.—(1) In the original Ssabanajew-Franck operation the incision was carried more obliquely and more nearly parallel with the costal arches _ and with less regard for the preservation of muscles and nerves by intramuscular separation. (2) Surgeons differ as to the direction of incising the posterior layer of the rectal sheath and the subjacent structures. (3) This operation requires a very lax stomach, capable of furnishing a rather long cone. The resulting fistula is more apt to be difficult to close than is the case in some of the other methods of gastrostomy. (4) The efficiency of the operation depends upon the valve-like nature of the opening over the edge of the costal cartilages _ the length of the cone _ the muscular action of the rectus _ the double change of direction of the gastric fistula (at first passing through the rectus, and then coming out at the skin wound) _ and upon the obliquity of the fistulous canal. (**5**) The deferring of making the opening into the stomach until all the cone-burying sutures are placed and tied prevents regurgitation and soiling of the wound in cases in which the stomach must be opened at once.

In adopting this type of operation one must be assured of a large, movable stomach, for the necessary reach to the costal arch is considerable. The fistula which is, at first, oblique, tends to lose its obliquity _ as the upper opening is generally pulled down below the rib arch by the continued drag of the stomach (in which cases the control of stomach contents is largely due to muscle action). The amount of stomach required to form the cone represents considerable waste of viscus. If the stomach be shrunken the operation is often not feasible.

The Ssabanajew-Franck method has probably been the most frequently performed method of gastrostomy. It is the method which has been the most extensively modified.

Kocher's Modification of the Ssabanajew-Franck Operation.—Instead of separating the fibers of the rectus muscle, Kocher retracted the rectus muscle outward _ and then employed the Witzel method (v. p. 266) of inserting the tube into the stomach (instead of pulling a cone of the stomach outward).

Albert's Modification of the Ssabanajew-Franck Operation.—Similar in all important essentials to Ssabanajew-Franck's operation, with the following exceptions: _ The primary incision begins 2.5 cm. (1 inch) below the margin of the ribs and passes almost vertically downward over the outer part of the rectus muscle (tending to be more vertical than oblique, as in Ssabanajew-Franck's). The secondary incision is made more directly over (than to one side of) the primary incision, and is placed somewhat nearer the costal margin. The stomach is bent more nearly directly upward _ rather than upward and outward.

Hahn's Modification of Ssabanajew-Franck's Gastrostomy.—Resembles, in general principle, Ssabanajew-Franck's method _ the chief difference being that the cone of stomach is brought directly up through the eighth intercostal space. The primary incision (Fenger's incision) is about 7.5 cm. (3 inches) long _ placed to the left of the left rectus muscle _ 2.5 cm. (1 inch) from, and parallel with, the left costal arch. The secondary incision is made later _ at the anterior end of the eighth left intercostal space, parallel with the ribs _ and about 2.5 cm. (1 inch) long. Incise skin and fascia in line of primary incision _ incise external oblique at right angle to fibers _ separate internal oblique in cleavage line _ divide transversalis transversely to cleavage line _ and transversalis fascia, subserous areolar tissue, and peritoneum in same line _ draw out long cone of stomach, as in Ssabanajew-Franck's operation _ suture serous coat of stomach to parietal peritoneum and fascial edges of abdominal wound _ make secondary incision in given line _ closed, pointed forceps are passed through the anterior end of the left eighth intercostal space and made to work their way through the intervening tissues, hugging the posterior aspect of the costal cartilages and guided by the finger in the abdominal wound _ the silk traction-suture is grasped by the forceps and the cone of stomach drawn through the eighth intercostal space _ the operation being completed as in the regular Ssabanajew-Frank's method. The danger of injuring the pleural cavity and the costal cartilages, together with the fact of there being no special advantage over the regular operation, are to be considered in undertaking this modification.

STAMM'S OR SENN'S METHOD OF GASTROSTOMY

Description.—In this method the tube is carried through an opening of its own diameter, in the anterior wall of the stomach, and buried *in situ* by a series of concentric sutures (purse-string fashion), which form successive tiers of infoldings of the stomach wall around the tube. A cone of stomach wall is thus invaginated, around the tube, into the interior of the viscus. The stomach cone is exposed by being drawn through the split outer third of the left rectus. This technic is the procedure of choice of Moynihan, of Burghard, and of many others, in the performance of gastrostomy. The method is simple, rapidly performed, and applicable to small, contracted stomachs, which are the kind so often encountered.

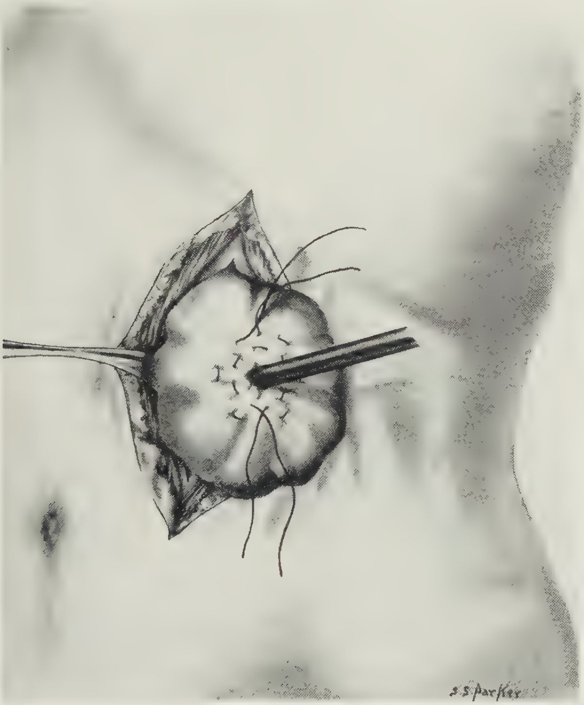


Fig. 3485.—Stamm's or Senn's Method of Gastrostomy — I; — The anterior stomach wall has been exposed through the split rectus muscle, and concentric tiers of purse-string sutures passed through the serosa and muscularis of the organ, ready to be tied in the order placed. The two sutures anchoring the tube to the stomach wall are not here shown.

Preparation — Position.—See General Surgical Considerations.

Landmarks.—Median line; left linea semilunaris; left costal arch.

Incision.—Vertical, over the outer third of the left rectus muscle, extending from the left costal arch downward, for 5 to 7.5 cm. (2–3 inches).

Operation.—The skin and fascia are incised — the outer rectal sheath of the left side exposed — and incised down its outer third. The fibers of the rectus are separated in their cleavage line — and the two parts of the split muscle retracted to either side. The posterior layer of the rectal sheath is incised in a line corresponding with the division of the anterior layer — and the peritoneum opened. Locate the stomach (being careful to differentiate it from the transverse colon) — and draw out into the abdominal wound a portion of its anterior wall which is somewhat nearer the greater curvature and cardiac end (as furnishing the best site for the mechanical features of the operation). The stomach may be found small, shrunken, and tucked away beneath the left lobe of the liver and the costal arch — so as to require some little difficulty in its delivery.

The adjacent regions are well packed off with gauze pads. A site of the anterior stomach wall is chosen about midway between the curvatures, and as far from the pylorus as convenient. A small opening is made through all the coats of the stomach at the selected point — scarcely as large as the rubber tube which it is to accommodate — and carefully guarding against cutting the posterior wall of the stomach (whether the opening be made by a stab-incision, or by cutting transversely through a ridged-up portion of the stomach). The tube is then inserted into the cavity of the stomach a reasonable distance, and is anchored by two catgut sutures passing through serosa and muscularis of the stomach, and through only the outer portion of the tube wall (to avoid drainage from the stomach). A series of concentric circular sutures, carried through the serosa and muscularis of the stomach, are now placed around the tube (Fig. 3485) — the number of circles of suture usually varying from two to four, according to the conditions of the parts, and availability of the stomach wall — and the distance between them being from 1.2 cm. ($\frac{1}{2}$ inch) to 1.9 cm. ($\frac{3}{4}$ inch). These sutures are usually of fine linen (though it would seem that chromic catgut would be better, to guard against tearing out, in possible future distensions of the stomach). As each tier of suturing is tied, beginning with the one nearest the tube (which is slightly depressed while tying the

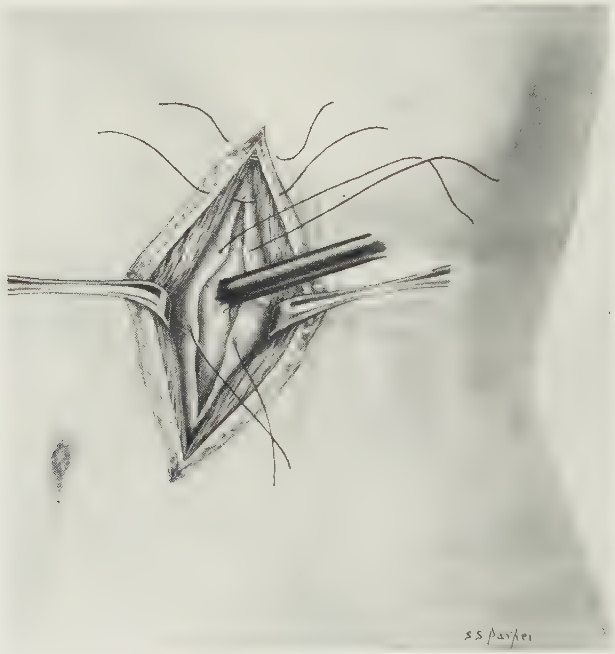


Fig. 3486.—The Same — II; — The stomach wall is being sutured to the parietal peritoneum and posterior layer of the rectal sheath. Other sutures are seen ready to approximate the split portions of the left rectus and the corresponding parts of its anterior sheath — and still others, ready to approximate fascia and skin.

suture), the tube is inverted into the stomach, along with a portion of the corresponding stomach wall equivalent to the width of stomach wall between the sutures. Each purse-string suture snugly grasps the tube _ until a sufficient cone of stomach wall has been inverted. Finally, the stomach wall is secured with chromic catgut, to the parietal peritoneum and rectal sheath by a few interrupted sutures, which also bring together the abdominal wound, on its lower level (Fig. 3486). The split rectus muscle and anterior rectal sheath are then sutured _ after which the fascia and skin are closed in the usual manner, up to the exit of the tube. A sectional view of the introduced tube and inverted stomach cone is shown in Fig. 3487.

After-treatment.—While some Surgeons begin feeding with peptonized milk at once, it is better to utilize the rectum for this purpose during the first one or two days, where this is possible. Where it is known in advance of closing the wound that the gastrostomy wound must be at once used for nutrition, the tube should be carried far enough to enter the duodenum _ and then artificial nutrition by the tube may be begun at once without danger of stomach leakage.

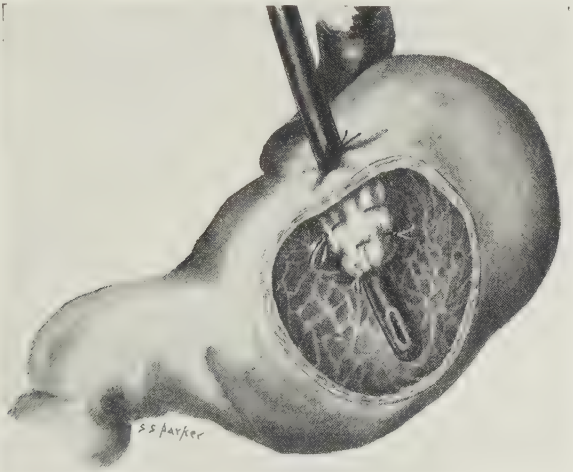


Fig. 3487.—The Same _ III; _ Sectional view of the inverted stomach cone and enclosed tube.

GASTROSTOMY

BY MARWEDEL'S METHOD

Description.—This operation resembles Witzel's in most of its essentials _ except that the tube is buried between the mucous coat, on the one hand, and the serous and muscular coats, on the other _ and that the parietal peritoneum is sutured to the skin before the stomach wall is attached to the edges of the abdominal incision.

Preparation _ Position.—See General Surgical Considerations.

Landmarks.—As in Witzel's operation.

Incision.—Oblique incision about 6 to 7.5 cm. (2½–3 inches) in length _ made over the left rectus muscle _ beginning near the median line and passing downward and outward somewhat more vertically than horizontally, though approximately parallel with and about 2.5 to 4 cm. (1–1½ inches) from the left costal arch.

Operation.—Incise skin and fascia _ clamp bleeding vessels _ and retract

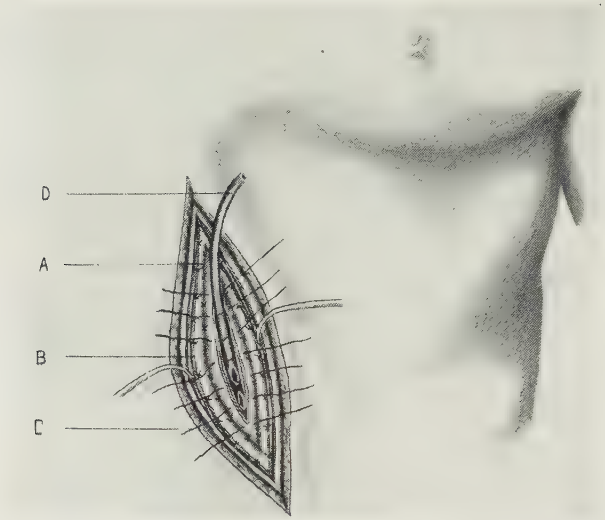


Fig. 3488.— Marwedel's Method of Gastrostomy _ I; _ Anchoring of the stomach and splitting of the stomach wall: _ A, Parietal peritoneum sutured into the lower part of the abdominal wound; _ B, stomach sutured to the parietal peritoneum and lower aspect of the abdominal wound; _ C, sutures through the serous and muscular coats of the stomach; _ D, tube about to be buried in the incised stomach wall.

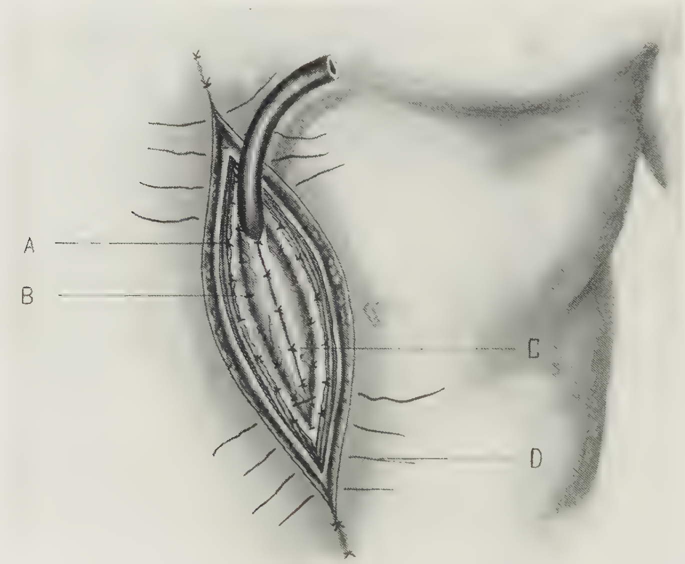


Fig. 3489.—The Same _ II; _ Burying of the tube and closure of the wound: _ A, Sutures uniting the peritoneum to the lower plane of the abdominal wound; _ B, sutures uniting the stomach to the peritoneum and lower plane of the wound; _ C, sutures burying in the tube between the mucous coat, below, and the serous and muscular coats, above; _ D, sutures through the skin, fascia, anterior rectal sheath, and upper part of the rectus muscle.

the lips of the wound. Expose the rectus muscle _ divide the anterior layer of the rectal sheath verticallly, nearer its outer part _ separate the fibers of the rectus vertically in their line of cleavage, by blunt dissection _ divide the posterior layer of the rectal sheath vertically – and the transversalis fascia, subserous areolar tissue, and peritoneum in the same line. The parietal peritoneum is now drawn out and sutured with interrupted gut to the skin at the margin of the abdominal wound. (See Comment.)

The anterior stomach wall is then drawn out and sutured to the parietal peritoneum at the margins of the abdominal wound, in the form of a narrow ellipse. For a distance of about 5 cm. (2 inches) and about parallel with the line of skin incision the serous and muscular coats are incised, carefully guarding against cutting through the mucous coat (Fig. 3488). The serous and muscular coats are then dissected from the mucosa to either side for a short distance. A rubber tube is now laid between the split coats of the stomach, which are then sutured over it with fine gut (Fig. 3489). The sutures at the lower end extend 1.2 cm. ($\frac{1}{2}$ inch) beyond the intended opening and are placed, but not tied. When all the rest are tied, an opening is made through the mucous coat in the same manner as in Ssabanajew-Franck's operation – immediately following which the tube is thrust into the stomach and the lower sutures at once tied. The margins of the abdominal wound are then sutured together with interrupted silk or silkworm-gut.

Comment.—(**1**) It would seem better to attach the parietal peritoneum to the lower edge of the abdominal wound (rather than to the skin) – and the stomach to the peritoneum thus attached – then the edges of the split rectus can be brought into direct contact, in finally closing the abdominal cavity. (**2**) Fenger's oblique subcostal incision is often used – about 7.5 cm. (3 inches) in length, placed to the left of the rectus and about 2.5 cm. (1 inch) below and parallel with the left costal arch. The operation may also be done in the median line. (**3**) The tube may be buried in the stomach wall before the latter is sutured to the edges of the abdominal wound – which is sometimes more convenient. (**4**) Surgeons differ considerably upon the incision and subsequent steps of the operation.

ESOPHAGO-JEJUNO-GASTROSTOMY

ROUX'S OPERATION

Description.—This ingenious technic consists in substituting a portion of the jejunum for the esophagus – tunneling under the superficial parts in the median line of the chest for the passage of the isolated loop of jejunum – which is anastomosed, below, to the anterior wall of the stomach (forming a jejunogastrostomy) – and, above, with the cervical esophagus (constituting a jejuno-esophagostomy). The operation has been successfully performed where an impassable or inoperable condition of the esophagus exists between the lower part of the neck and the cardiac orifice of the stomach. The isolated portion of jejunum retains its connection with the proximal portion of its mesentery, thus insuring its blood-supply. The procedure is only rendered possible by the vascular arrangement of the parts – which is described by Kocher as follows: – "Roux points out that the vessels supplying the jejunum are distributed on a far more regular plan than those which supply the bowel lower down, especially the ileum. In the case of the jejunum, there are numerous short vasa recta given off the last arterial arch, while spaces between the vessels which go to form the latter make it easy to divide the mesentery without extensively damaging the circulation of the intestine. He found that by ligaturing four or five of these afferent vessels and, at the same time, preserving the peripheral arch, the vitality of the gut was maintained by the vasa recta quite satisfactorily (Fig. 3490)." This, then, makes possible the isolation of a considerable piece of the jejunum – the anal end of which is brought up in front of the transverse colon and anastomosed with the anterior wall of the stomach (Fig. 3491), near the lesser curvature _ and the gastric end is carried through a tunnel in the connective-tissue plane of the abdomino-thoracic wall, and anastomosed with the proximal (oral) end of the cervical esophagus. The mesentery of the aspect of the jejunum toward the stomach is not divided. The peristaltic wave of the jejunal segment, which substitutes the esophagus, helps to pass the food on down, and prevents regurgitation.

An incision is next made just below the suprasternal notch, slightly to the left, into the connective-tissue plane _ and, through this, a pair of long slender forceps are carried and made to tunnel their way in this plane, down to the abdominal opening, in the same plane. The segment of jejunum, wrapt in gauze wrung out in saline solution, is seized by the forceps and carefully drawn through the subcutaneous tunnel (Fig. 3492) _ and sutured into the wound just below the suprasternal notch. A stomach-tube is now carried through the jejunal segment, from the upper end, and on into the stomach _ being so anchored as not to slip from its position. In drawing the transplant into position, the sheath of the rectus is cut, and, to limited extent, some of the fibers of the muscle (Fig. 3493).

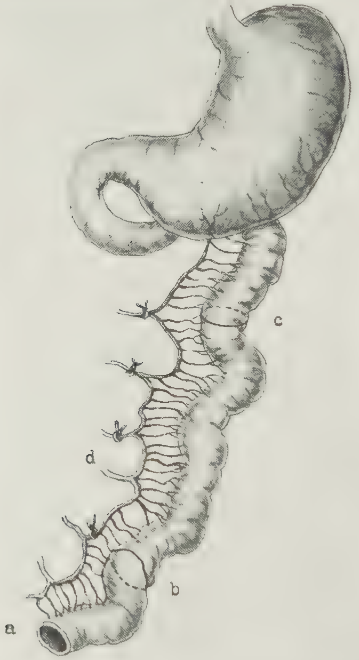


Fig. 3490.—Esophago-jejuno-gastrostomy by Roux's Technic _ I: _ **a,** The isolated loop of jejunum showing its preserved blood-supply; _ **d,** ligated vasa recta, from the last arterial arch _ but preserving the peripheral arch; _ **c, b,** the jejunal segment intended for transplantation. (Figs. 3490–3493 modifications of the Roux illustrations.)

The open ends of the main jejunum, temporarily clamped, are united by Murphy button or by end-to-end anastomosis. This may be done either before or after transplanting the jejunal segment. The abdominal wound is entirely closed, but for the exit of the piece of jejunum.

The piece of jejunum acts automatically, carrying the food to the stomach by its peristaltic waves.

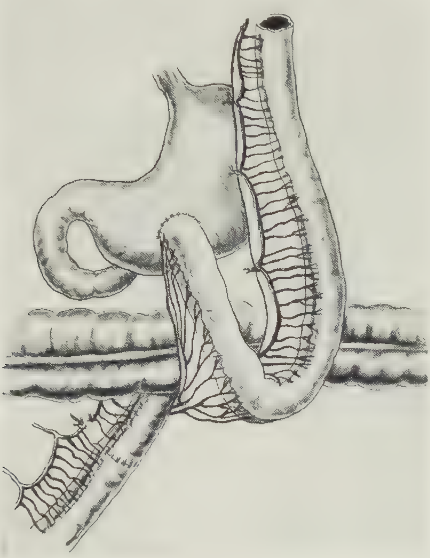


Fig. 3491.—The Same _ II: The jejunojejunostomy of the ends of the jejunum between which the jejunal segment, intended for transplantation, has been excised; _ the anal or distal end of the isolated jejunal segment brought up in front of the transverse colon and anastomosed with the anterior wall of the stomach.

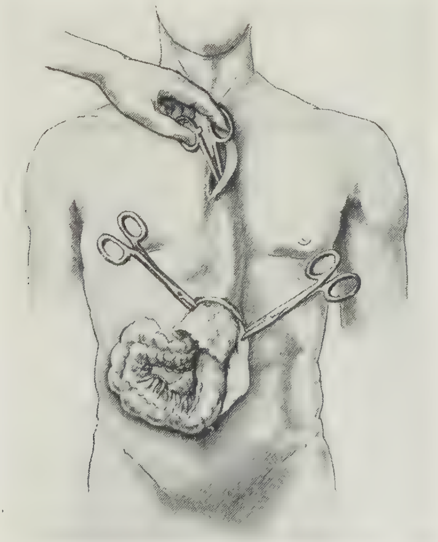


Fig. 3492.—The Same _ III; _ Drawing the gastric end of the jejunal segment, wrapt in wet gauze, through the tunnel in the connective-tissue plane of the abdominothoracic tract.

The anal end of the jejunal segment may be anastomosed to a freshly made wound in the anterior stomach wall, or to the freshened margins of a

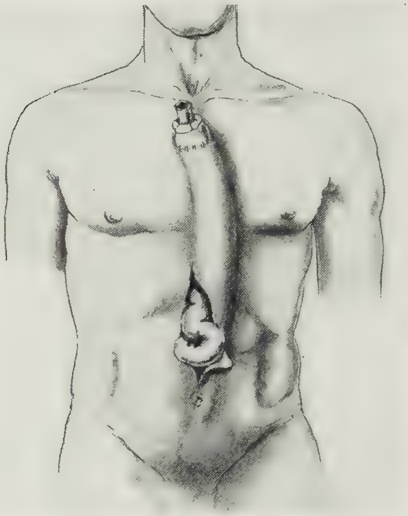


Fig. 3493.—The Same – IV; – Anchorage of the gastric end of the jejunum just below and a little to the left of the suprasternal notch, preparatorily to anastomosing it with the lower end of the proximal portion of the esophagus, when divided, later. The abdominal wound is about to be closed. A rubber tube has been temporarily passed down the jejunal segment, into the stomach, and is tied into the upper end of the intestine – through which feeding is at first carried on.

preceding gastrostomy opening. The oral end of the segment is always first anchored in the cervical wound, and, at a later date, anastomosed with the lower end of the upper portion of the divided esophagus.

OPERATIVE TREATMENT OF GASTRIC FISTULÆ

Gastric fistulæ are of two kind – external gastric fistulæ, or gastrocutaneous fistulæ – and internal gastric fistulæ.

External Gastric Fistulæ, or Gastrocutaneous Fistulæ – connect the lumen of the stomach with the surface of the skin – and are generally due to wounds, gastric ulcers, malignant tumors of the stomach, hepatic and subphrenic abscesses, costosternal caries, pancreatic cysts, sometimes to strangulated hernia, and to such surgical procedures as gastrostomy.

Internal Gastric Fistulæ – connect the stomach with some neighboring organ (or even one part of the stomach with another part) – and are due to wounds or to disease. Internal fistulæ usually extend between the stomach and the colon – but have been known to extend to the duodenum and other parts of the small intestine, esophagus, and gall-bladder – even into the chest, to the pleuræ and pericardium.

Operative Treatment of External Gastric Fistulæ by Excision.—An elliptic incision is made, surrounding the skin opening of the fistula (Fig. 3494) – and this is carefully deepened down through the structures of the abdominal wall, into the peritoneal cavity. Adhesions are due to be encountered on entering the abdominal cavity – and should be carefully separated down to the gastric origin of the fistula. As one proceeds from skin to stomach, the structures present more or less of a mushroom appearance – the abdominal wall forming the mushroom, and the fistula, the stalk – as shown in Fig. 3495. Finally, when the gastric end of the fistula has been reached, and the stomach exposed and the immediate vicinity of the fistula cleared, the contents of that

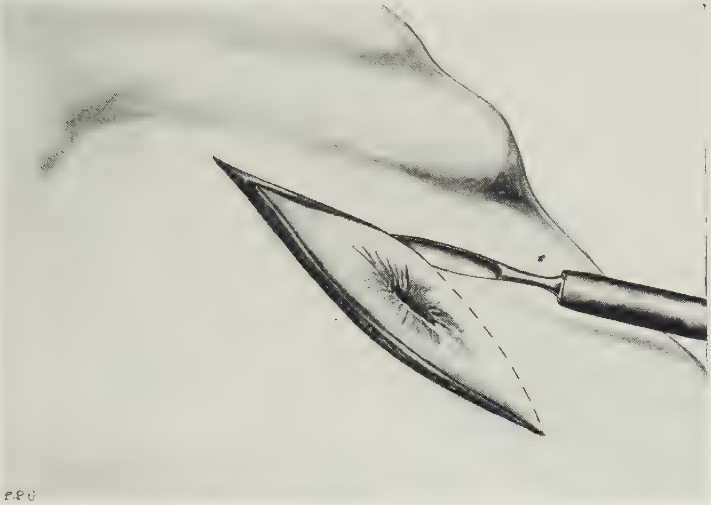


Fig. 3494.—Excision of an External or Gastrocutaneous Fistula – I; – Elliptic incision for the excision of the cutaneous end of the fistula.

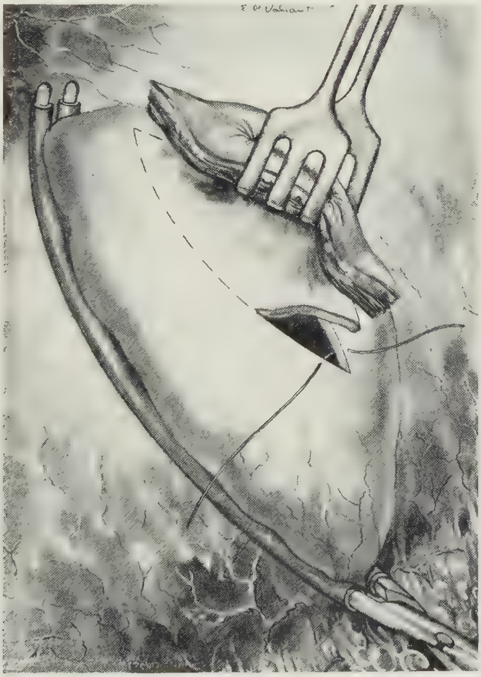


Fig. 3495.—The Same – II; – The excised elliptic piece of the abdominal wall, including the cutaneous opening and stalk of the fistula, has been seized with forceps – while the beginning of the elliptic excision of its gastric end is being made – after which the margins of the stomach wall are sutured together before the elliptic excision is continued.

portion of the stomach are pressed away, and a curvilinear clamp applied in such a way as to isolate the fistula-bearing aspect of the stomach. The parts are well protected by gauze-packing against soiling from the opened stomach. The mushroom top of the fistula is seized with toothed clamps, so as to better manipulate it. The gastric end of the fistula is now also elliptically excised, as was the cutaneous end _ but it is convenient, for the purpose of avoiding soiling, to carry on the excision and the suturing *pari passu*. One end of the ellipse is incised _ and through-and-through stitches of all the coats is at once applied. After a few of these have been inserted, they are clamped and then usually employed as tractors. Thus the sides of the ellipse are incised and sutured by steps _ until the opposite end is reached (Fig. 3496). A seromuscular Lembert suture then buries in the marginal suture _ completing the operation. The abdomen is closed as usual.

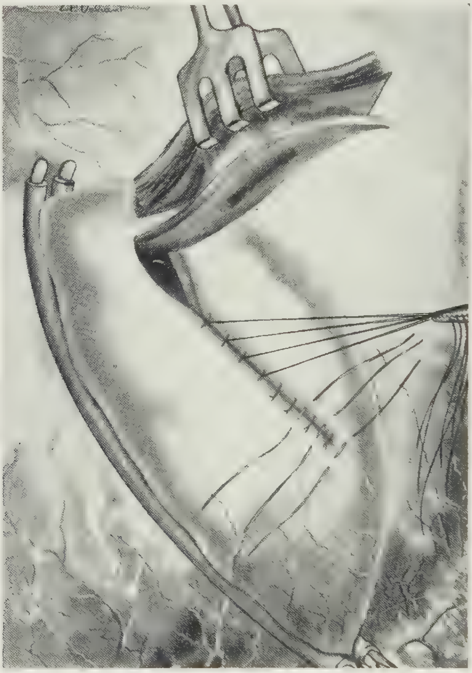


Fig. 3496.—The Same _ III; _ The elliptic excision has been continued almost to the opposite end _ while the first third of the stitches has been placed and tied, and the middle third placed and used as tractors. The outlying seromuscular sutures have been placed over the first third of the stomach wound to show the manner of their introduction _ (not, of course, being ordinarily placed until all of the marginal sutures are tied).

Sometimes external gastric fistulæ are treated as fistulæ often are in other regions, by attempting to bring about obliteration of their tract by irritation and adhesion of their wall.

Operative Treatment of Internal Gastric Fistulæ.—There is such a wide range of conditions in this class of gastric fistulæ that each case, almost, must be treated as indicated by its own peculiarities. The general methods of procedure employed for the cure of the most frequent type of internal gastric fistula _ gastrocolonic fistulæ _ will be considered: _

Operation for Gastrocolonic Fistula by Excision of the Fistulous Tract and Closure of the Gastric and Colonic Orifices.—This is the ideal technic, where it is possible to carry it out _ as it restores the parts to their normal status. The procedure, however, is generally far from simple _ as the freeing of extensive adhesions, and the resections of considerable parts of stomach and intestine, together with more or less complex forms of anastomoses, are often necessitated.

Operation for Gastrocolonic Fistula by Exclusion of the Gastrocolic Fistula.—This may be accomplished in various ways. The colon may be divided proximally and distally to the fistula _ followed by the closure of all four ends of the colon _ after which the transverse colon is anastomosed with the descending colon _ the portion of the colon attached to the stomach being left as a diverticulum to the stomach. The colon may be divided on both sides of the fistula _ followed by an end-to-end anastomoses of the ends of the transverse colon _ and the closure of the two ends of the gastric portion of the colon. The transverse colon above the fistula may be anastomosed with the sigmoid colon below _ after which, the ends of the colon on each side of the fistula are closed.

Operation for Gastrocolic Fistula by Short-circuiting the Fistula.—A colo-colostomy may be performed, of the transverse colon above and below the fistula. A colo-colostomy between the ascending colon and the sigmoid colon may also be done.

Operation for Gastrocolic Fistula by Colostomy or by Jejunostomy.—These are sometimes resorted to as palliative measures only.

PYLOROPLASTY

HEINEKE-MIKULICZ OPERATION

Description.—The procedure consists in increasing the size of the pyloric outlet of the stomach, or the pyloroduodenal junction _ by means of a horizontal, or mid-axial incision through its anterior wall, with its center at the site of greatest constriction, followed by a vertical suturing of the wound. The operation is, in reality, a form of gastro-duodenostomy, which would be a more properly descriptive title.

Indications and Contraindications.—This technic is indicated in benign constriction of the pylorus, and where the structures are mobile and pliable _ but is contraindicated where the region is infiltrated with tumor, or old scar-tissue, and in the presence of dense pyloric adhesions, and in active ulcerative conditions. The operation is to be especially chosen in spasm of the pylorus. Under most of the other conditions for which it has been used the stenosis has shown a tendency to be re-established.

Preparation _ Position _ Landmarks.—As for gastrojejunostomy.

Incision _ Operation.—The abdomen is opened by a right paramedian section. Hemorrhage is controlled, and the edges of the wound, especially upon the right side, are well retracted. The pylorus is isolated _ any slight adhesions being separated by blunt dissection _ and brought into the abdominal wound as well as possible. As already mentioned, dense adhesions are usually a contraindication to continuing the operation. A rubber-covered clamp is applied upon the gastric side of the pylorus _ the posterior blade of the clamp passing through a limited opening in a non-vascular part of the gastrocolic omentum, into the lesser cavity _ and another clamp upon the duodenal side of the pylorus. The neighboring regions are well guarded by gauze-packing.

A horizontally curved, axial incision is made through the anterior wall of the pylorus, beginning over the gastric aspect and ending over the duodenal aspect of the pylorus, midway between its superior and inferior borders, _ through all the coats _ and from 6.3 to 7.5 cm. ($2\frac{1}{2}$–3 inches) in length (Fig. 3497). The incision is, at first, about 2 cm. ($\frac{3}{4}$ inch) in length _ and, through this, the right forefinger is inserted and carried on into the pylorus, to determine by palpation the degree of constriction, and the thickness of the wall, as estimated by the finger within and the thumb without. The incision is then carried through the strictured portion, on into the healthy stomach and duodenum, up to the desired length. By means of wound-hooks (or silk tractor-loops), inserted at the center of either side of each lip, the axial wound is drawn upon until it first becomes diamond shaped and then transverse

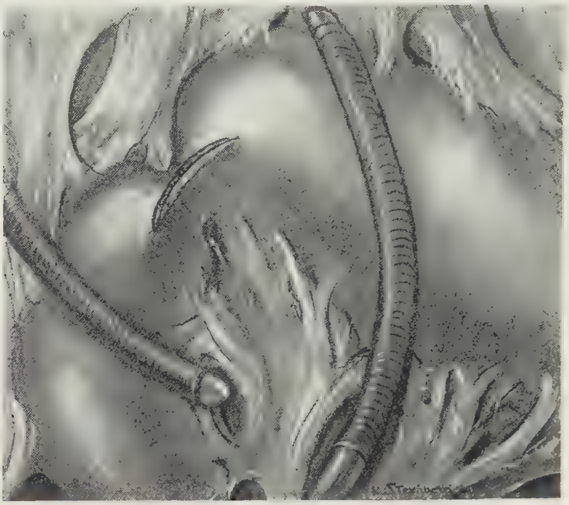


Fig. 3497.—PYLOROPLASTY (Heineke-Mikulicz) – I; – The stomach and duodenum are clamped (the posterior blade of the stomach clamp passing into the lesser peritoneal cavity) – after which the axial incision is made through the anterior wall of the constricted pyloric outlet.

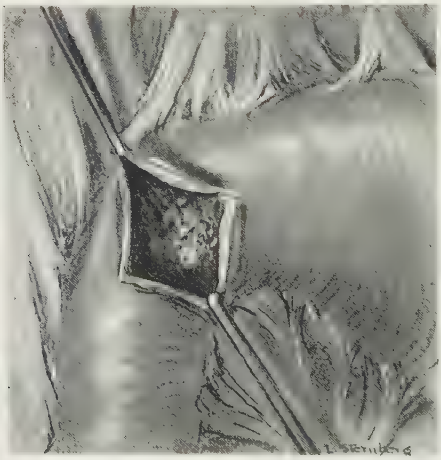


Fig. 3498.—The Same – II; – The incision made in the long axis of the gastroduodenal constriction is now retracted in the opposite direction by means of wound hooks placed opposite the middle of each wound lip – while two rows of interrupted sutures are being placed, the inner, through all the coats of the wound margins, and the outer, consisting of Lemberts, through the serous and muscular coats.

(Fig. 3498) _ and, while held in this last position, the sutures are applied. Interrupted sutures are used, and either silk or linen is usually employed. The first, or inner tier includes all the coats _ and the second, or outlying tier is made up of seromuscular sutures. Sometimes the edges of the mucosa are sutured separately, constituting three tiers. The sutured parts are then thoroughly cleansed and dropped back into position _ the slit made by the blade of the clamp sutured _ and the abdomen closed in the usual manner. The resulting pylorus is considerably increased in size (Fig. 3499).

Comments.—Sometimes in dense, thick walls, where, however, the infiltration is not sufficient to contraindicate the operation, a small diamond-shaped excision of the site is made _ to aid in the approximation of the two margins.

The suturing may be done as above, but over an absorbable tube or button _ as in end-to-end entero-enterostomy over a decalcified bone-button.

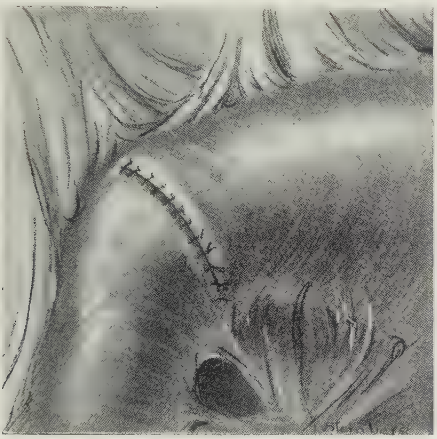


Fig. 3499.—The Same _ III; _ The sutures are tied _ and the formerly contracted pylorus is now shown of larger caliber than normal.

If the anastomotic opening be too short, it is likely to lead to a repetition of the condition _ and if too long, it may cause too much tension upon the line of sutures.

Some Surgeons use continuous suturing of both tiers. The stitches should be close together, and take an especially good hold, as the pull upon them may be considerable in some cases.

After once entering the lumen of the viscera, it is well to lengthen the incision with blunt-pointed scissors.

LATERAL OR PYLORIC GASTRODUODENOSTOMY

FINNEY'S OPERATION

Description.—This procedure consists of the anastomosis of the pyloric end of the stomach and the first part of the duodenum _ its object is to increase the pyloric outlet of the stomach _ and its use is in non-malignant and non-spasmodic cases of pyloric obstruction. The operation consists, briefly, in the making of an extended Heineke-Mikulicz incision in the gastroduodenum, followed by the suturing of the margins of the incision in a special manner _ after mobilizing the upper portion of the duodenum. Mayo considers extensive disease, adhesions, and a short gastrohepatic omentum, especially if accompanied by scar-tissue, as contraindications.

Preparation _ Position _ Landmarks _ Incisions.—As for gastro-enterostomy, in general.

Operation.—The structures are best exposed through a right paramedian incision, with the outward displacement of the right rectus muscle. The pyloric portion of the stomach and the upper aspect of the duodenum are exposed and carefully examined. One may be at first discouraged by the adhesions encountered in the field, but by systematically attacking these with a gauze-covered finger, and by blunt, and even sharp dissection, a condition of affairs favorable to proceeding may often be secured. The freeing of all interfering adhesions, and the mobilization of the pyloric end of the stomach, the pylorus, and the first and second portions of the duodenum are absolute prerequisites for the successful performance of the operation. In the following description the interpretation of the operation as given by Gould will be largely followed. Not only must abnormal adhesions be overcome, but some of the normal peritoneal coverings must be divided. To quote from Kocher, _ "To free the duodenum in this way, it is necessary to divide the parietal peritoneum to the right of the descending part of the duodenum. The membrane is divided vertically over the front of the right kidney, a little to the left of the descending limb of the hepatic flexure of the colon. We recommend that this delicate layer of the parietal peritoneum be divided with the knife two fingerbreadths to the right of and parallel to the second part of the duodenum, so that the peritoneum covering the anterior surface of the duodenum may not be injured, as would be the case were the peritoneum simply torn through. If the divided peritoneum adjacent to the second part of the duodenum be grasped and pulled forward, the fingers can be introduced behind

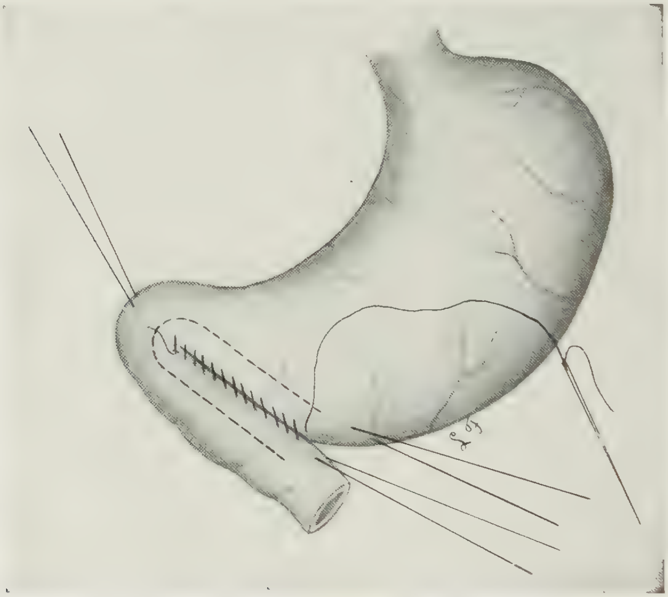


Fig. 3500.—Finney's Gastroduodenostomy _ I; _ Illustrating the scope of the operation. The approximation of the duodenum and stomach is here shown accomplished by Finney's original technic _ in which temporary thread-tractors were employed, instead of clamps, as now used.

the duodenum so as to raise it from the vertebral column, the vena cava, and the aorta. By the above manipulations the second part of the duodenum is rendered so movable that it can easily be brought up to the anterior surface of the pyloric portion of the stomach above the greater curvature" (Figs. 3586 and 3588). After this freeing, the duodenum and stomach are clamped in the following manner (in Finney's original description they were held in contact by traction sutures, Fig. 3500); _ a longitudinal fold of about 6 cm. (2½ inches) of the anterior aspect of the duodenum is clamped, the inner limb of the clamp passing up to the pyloric sphincter; _ a corresponding portion of the anterior wall of the stomach at the lower portion of its pyloric aspect is similarly clamped, the point of the outer limb of the stomach clamp meeting the point of the inner limb of the intestinal clamp (Fig. 3501). When the clamps are clasped and brought together, the gastroduodenal angle is put upon the stretch _ thus controlling hemorrhage and leakage from this area, otherwise difficult to manage. A seromuscular continuous suture is now carried down from the pyloric angle through the aspects of stomach and duodenum in contact _ being left long at the angle of separation (Fig. 3502). A U-shaped incision is next made into the lumen of stomach and intestine, directly over the center of each clamp, and continuous with each other around the gastroduodenal angle.

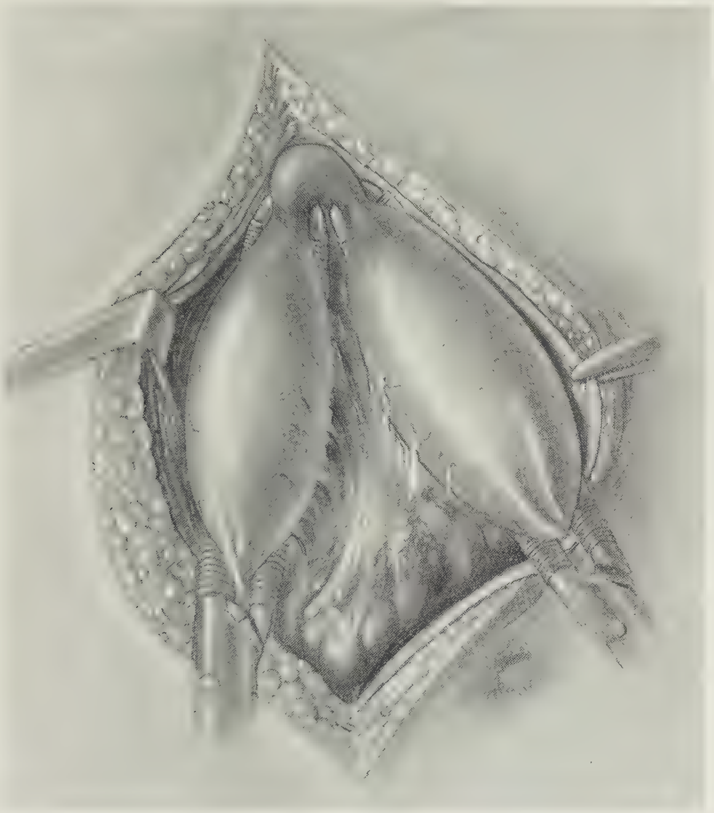


Fig. 3501.—The Same _ II; _ Clamping the folds of stomach and duodenum to be approximated. The points of the inner limbs of the clamps are shown in contact. The stomach-clamp is parallel with the greater curvature. The larger part of the duodenal circumference is grasped in the duodenal clamp.

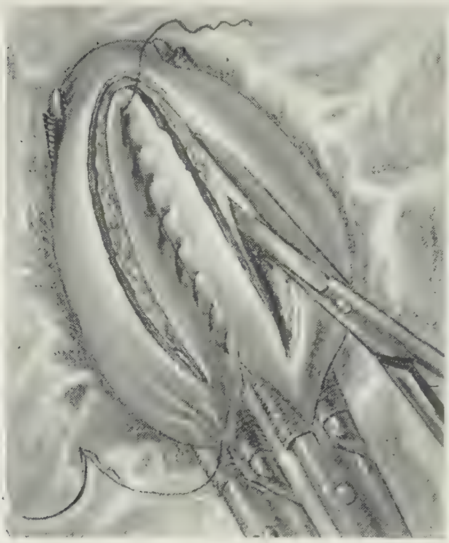


Fig. 3502.—The Same – III; – The clamps have been approximated, bringing into apposition the gastric and duodenal folds. The posterior layer of the seromuscular suture has been placed, its needled end being left free. The serosa and muscularis of the gastric and duodenal folds have been incised in an inverted U-shaped manner, the incision passing somewhat nearer the contiguous aspects of the folds. Scissors are in the act of incising the mucosa, and excising any redundancy of it which may bulge.

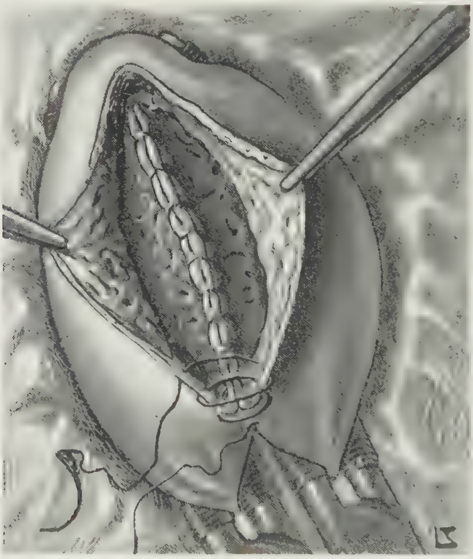


Fig. 3503.—The Same – IV; – The marginal layer of the through-and-through sutures of all the coat, – the posterior tier has been passed – and is rounding into the anterior tier. The posterior tier of the outlying seromuscular suture (without needle) is seen – ready to be continued into the anterior tier.

The protruding mucous membrane, especially that of the stomach, is trimmed off even with the seromuscular margins of the openings. The incised edges of stomach and intestine are now sutured together with an overhand running stitch of all coats – beginning with the posterior lips and ending with the anterior, knotting the suture where the return stitch begins, the suture ending at the pyloric angle, where it began (Fig. 3503). If the parts are too tense to enable this stitch to be completed otherwise, the clamps are relaxed before its last portion is completed. Finney uses mattress-sutures, placed prior to incising, to close in the anterior lips. The clamps are now taken off and a continuous seromuscular suture is carried around the anterior aspect of the wound (Fig. 3504). The parts are placed *in situ*, and the abdomen closed.

Comment.—The normal size of the pyloric outlet should be calculated for, or a slight overcorrection, in planning the length of the incision – which Finney makes about 10 cm. (3 inches).

Some Surgeons insert the three tractor-sutures first, independently of the employment of clamps – placing one linen tractor at the highest point of the duodenum – the second, 10 cm. (4 inches) further down upon the duodenum – and the third, in the stomach wall opposite the second duodenal one.

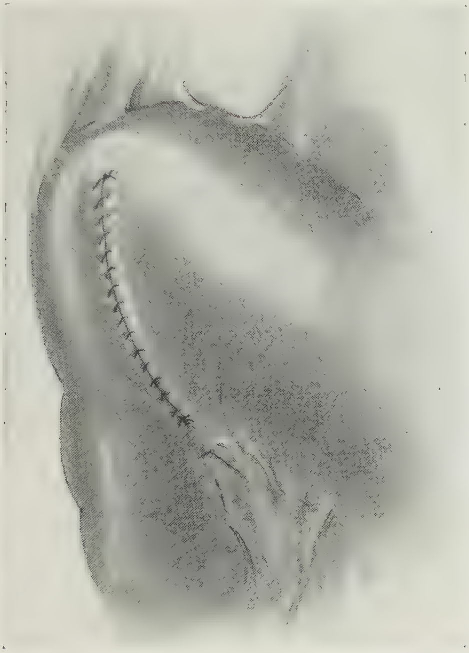


Fig. 3504.—The Same – V; – The completed operation.

The marginal suture is usually of chomic catgut – and the seromuscular suture, of fine linen. (Finney employed mattress-sutures in the seromuscular layer.)

Finney and Friedenwald (quoting from Douglas) report 100 operated cases within the thirteen years ending in 1915 – with a mortality of 5 per cent. – and with satisfactory results in 88 per cent. of the number from which results were obtainable (or in 93 per cent. of those surviving the operation). Finney and Friedenwald write that "the only contraindications to the operation are inability to mobilize the duodenum when adhesions are too dense, and thickening and infiltration about the pylorus due to hypertrophic forms of ulceration are present _ and in atony, or gastroptosis with slight motor insufficiency."

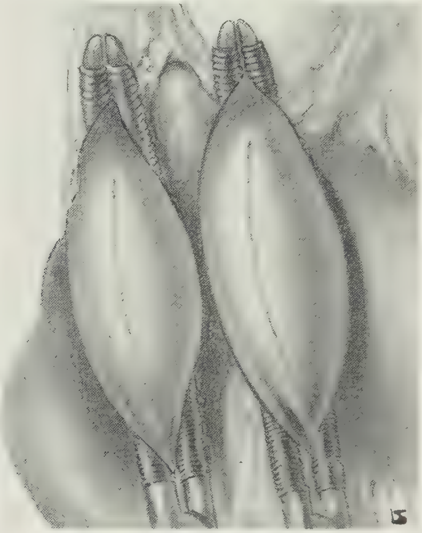


Fig. 3505.—An Alternative Method of Performing the Kocher-Finney Gastroduodenostomy _ in which a pouch of duodenum and a pouch of the pyloric end of the stomach are simply grasped by separate forceps which pass beyond their upper aspects _ rather than produce a yoke-like arrangement of the parts _ thereby securing greater simplicity of procedure _ especially in the suturing. The lines of incision in duodenum and stomach are indicated. The suturing is, here, performed as in gastrojejunostomy (q. v.).

The anastomosis may also be accomplished _ and somewhat more simply _ by approximating portions of the stomach and duodenum in the ordinary manner (Fig. 3505).

OPERATIONS FOR HOUR-GLASS OR SADDLE-BAG STOMACH

Description.—In hour-glass stomach there is a more or less marked division of the normal stomach into two cavities _ a cardiac pouch and a pyloric pouch. The divisional constriction, which may be shallow or deep, usually lies nearer to the pyloric than to the cardiac end of the stomach _ though it may lie at any site between the two. The loss of normal contour is generally upon the greater curvature _ but may be upon the lesser. These constrictions are never congenital _ are always pathologic _ and are usually due to cicatricial contraction (generally from an ulcer), or to adhesions and compressions without. Exceptionally the stomach is triply pouched.

The objects of all operations for this condition are the same, _ the enlargement of the opening between the two pouches, and the provision for the satisfactory emptying of the stomach. A large number of technical procedures have been devised to these ends _ some of the chief ones of which will be here given. In all of these operations the stomach is exposed in the usual way, generally through a right paramedian abdominal section. The field is packed off from soiling _ and the visceral contents are controlled by special gastric and intestinal clamps. In complicated cases a large range of gastro-intestinal surgery may be called into play. The conditions should be as fully determined in advance by x-raying as possible _ and further carefully investigated after exposure.

Lateral Gastrogastrostomy (Woelfler).—The operation consists in the anastomosis of the contiguous aspects of the two pouches of an hour-glass stomach, for the purpose of making a common cavity. The method is more applicable to a symmetrically deformed hour-glass contraction, where the two pouches are approximately of the same size and the intervening connection fairly large. Having exposed the abdominal cavity, the deformed stomach is brought as well into the wound as possible _ the portion intervening between the two pouches being apt to be bound down to the pancreas and gastrohepatic ligament. Having packed off the adjacent regions with gauze, the Assistant clamps and holds first one and then the other gastric pouch conveniently to the Surgeon _ the clamps including most of the anterior stomach wall, and the greater curvature and omental attachment, so as to obliterate the pouches.

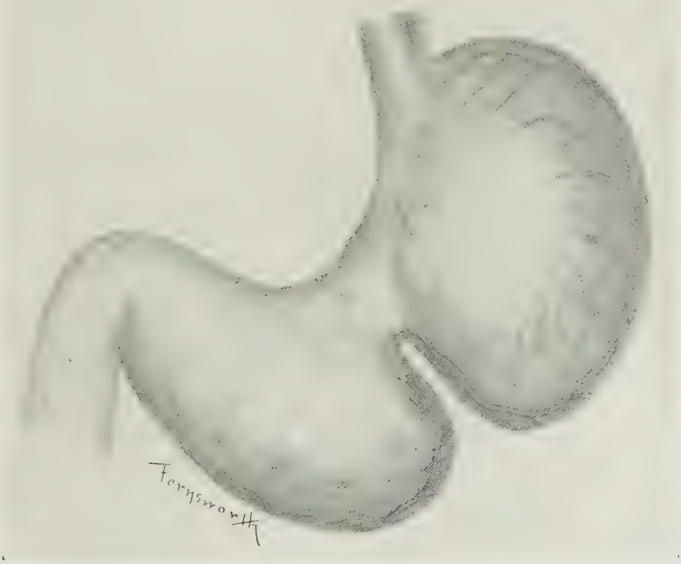


Fig. 3506.—The Pouches of an Hour-glass Stomach.

Incisions are made upon those aspects of the two pouches which face each other _ extending into their lower borders, so as to re-establish a greater curvature (Fig. 3507). These openings pass through all the coats of the stomach. Bleeding vessels are clamped and gut-ligatured. The pouches are so held as to minimize the escape of intestinal contents. An Assistant now approximates the two openings, while a continuous seromuscular suture is first applied posteriorly, followed by a through-and-through suture of the margins (Fig. 3507). Then the outlying line of sutures through the serous and muscular coats, which had been applied posteriorly only, is now continued on around the sides and in front _ thus completing the double line of suturing. The stomach is now returned to its position and the abdomen closed.

Comment.—The openings are so calculated that they will correspond with the greater curvature of the stomach _ and increase this when the two halves of the stomach are united. In some cases of non-symmetric hour-glass contraction of the stomach, the pyloric pouch is bent over upon a vertical axis and sutured along an elliptic outline to the cardiac pouch _ an opening is then made in the pyloric pouch, and through this an incision is made through the two walls which have been sutured together and which now intervene between the two pouches _ the margins of this incision through the double walls is then whipped over with a buttonhole stitch _ and then the original incision

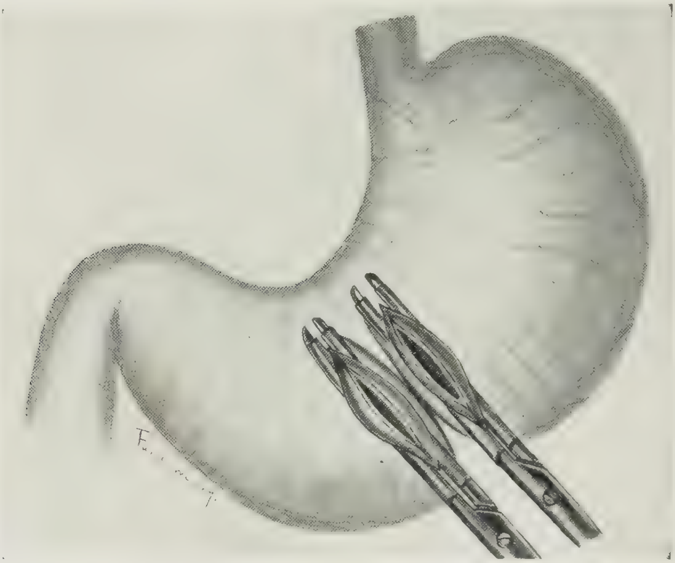


Fig. 3507.—Gastrogastrostomy for Hour-glass Stomach; _ The two pouches have been clamped and incised, and are approximated ready for suturing. (Redrawn from Gould.)

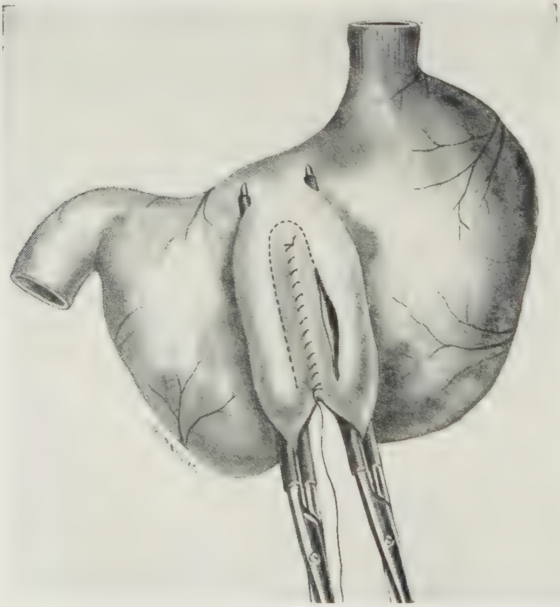


Fig. 3508.—The Kammerer-Finney Method of Gastrogastrostomy for Hour-glass Stomach.

in the pyloric pouch is closed by sutures _ and the abdomen closed _ constituting Watson's operation.

Instead of making two narrow elliptic excisions upon the opposing faces of the pouches, it may be only necessary to make an incision of the seromuscular coats, with a narrow elliptic excision of the bulging mucosa.

Operation for Hour-glass Stomach by The Kammerer-Finney Method of Gastrogastrostomy.—This is an application by Kammerer, to the two pouches of the stomach, of the same principle which Finney applies to the anastomosis of stomach and duodenum, in constriction of the pylorus, in his operation of pyloroplasty. It is sometimes called Kammerer's gastroplasty, but it might be fairer to call the technic the Kammerer-Finney operation. A clamp is applied to the cardiac pouch, and another to the pyloric pouch, and the folds, thus included, brought into contact with each other. A seromuscular suture joins the posterior aspect of the approximated folds, from their isthmus down to their free ends. An inverted U-shaped incision is then carried through all the coats of both folds of the stomach, including the isthmus, being placed nearer the adjacent limbs of the clamps than the outer limbs (Fig. 3508). (Or the serous and muscular coats may be first incised, and the bulging mucosa elliptically excised.) A through-and-through overhand suture then unites the margins of the stomach pouches _ after which the anterior aspect of the seromuscular suture is completed. The method is especially applicable in those cases where it is difficult to free the posterior wall of the stomach.

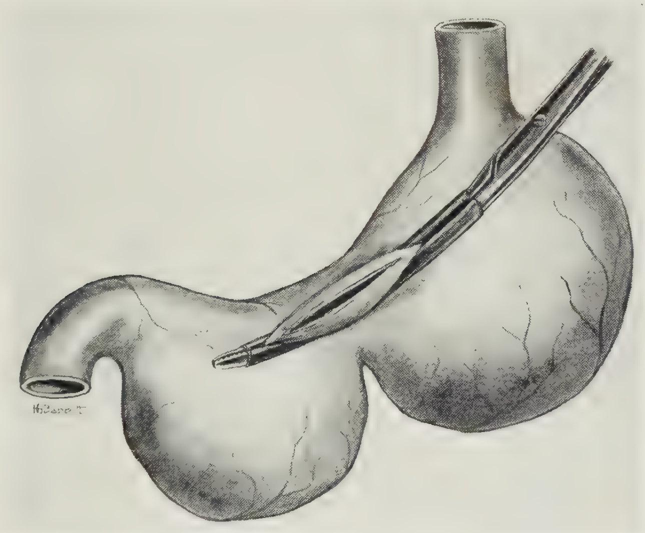


Fig. 3509.—Gastroplasty for Hour-glass Stomach, Upon the Principle of the Heineke-Mikulicz Operation _ I; _ The anterior wall of the isthmus (between the saddle-bags) is clamped in the long axis of the stomach, ready for incision.

Gastroplasty for Hour-glass Stomach _ by the Principle of the Heinecke-Mikulicz Pyloroplasty.—This is a procedure for widening the opening between the two pouches of an hour-glass stomach, similar, in principle and application, to the pyloroplastic operation of Heineke and Mikulicz. The contracted portion of the anterior wall of the stomach (the portion between the saddle-bags) is seized with stomach forceps in the long axis of the stomach. An incision into the lumen is then made in the long axis of the clamped portion (Fig. 3509) – and the protruding mucous membrane excised. While the anterior stomach wall is being drawn forward by forceps, so as to prevent leakage, the clamps are shifted – and are made to grasp the opening at a right angle to their first hold (Fig. 3510). The opening is then closed, first by a marginal suture of the edges, and, finally, by a seromuscular suture of the anterior aspect. As the sites which were the ends of the incision in the first position of the clamps tend to pull out of the second position of the clamps, it should be seen that they are drawn well within and held during the process of suturing.

Operation for Hour-glass Stomach by Anterior Gastrogastrostomy.—It may happen that the isthmus between the two saddle-bags is so bound down by adhesions that it cannot be mobilized for utilization in any way. In such instances it may happen that the only form of gastrogastrostomy which can be performed is to anastomose the anterior walls of the two pouches – and, even to accomplish this, they must be capable of mobilization and approximation. If these conditions be present, each pouch is clamped in the transverse axis of the stomach and incised, as shown in Fig. 3511. The openings are sutured together in the usual manner by two rows of sutures. The final result is shown in Fig. 3512.

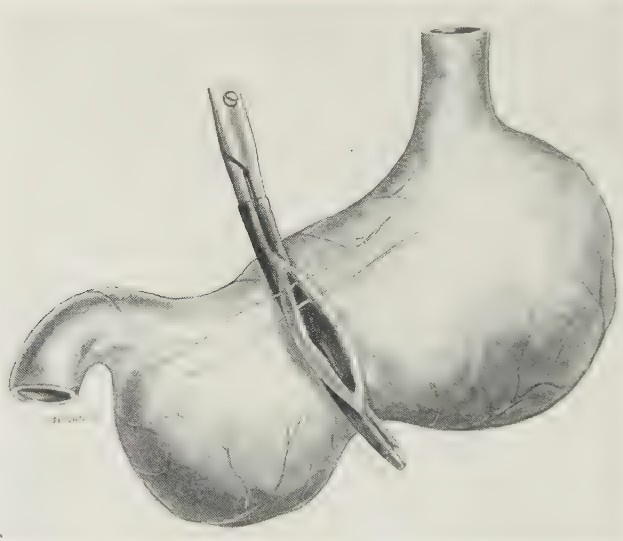
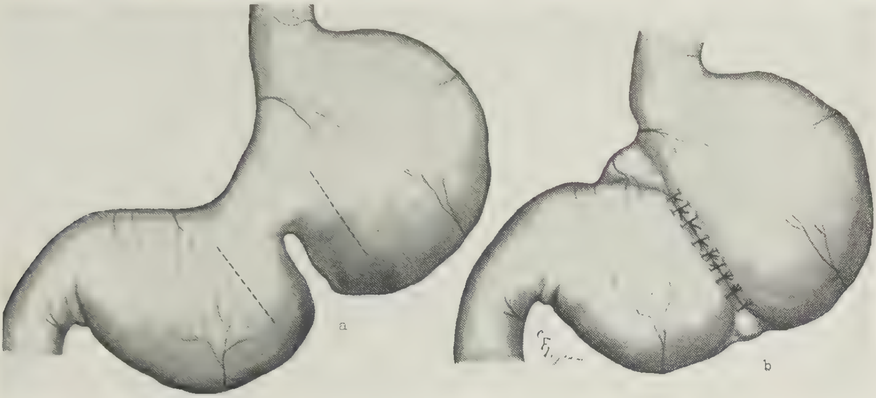


Fig. 3510.—The Same – II; – The incision has been made and the clamp shifted to the transverse axis of the stomach – the opening being ready for suture, first with a marginal stitch, and then with the seromuscular.

Operation for Hour-glass Stomach by Anterior or Posterior Gastrojejunostomy with the Cardiac Pouch.—This procedure is generally considered the operation of choice in hour-glass stomach. The posterior operation is to be preferred, unless that aspect of the stomach cannot be mobilized, or otherwise utilized – when the anterior operation may be adopted. The anastomosis takes place between the first approximable part of the jejunum (distal to the duodenojejunal juncture) and the posterior aspect of the cardiac pouch. In the cases of the usual application of this technic (hour-glass stomach following the contraction of an ulcer), the cardiac pouch is usually very large (even sometimes larger than a normal stomach), and the pyloric pouch of small or insignificant size, and with no obstruction to its outlet _ so that the anastomosis takes place between the jejunum and the cardiac pouch. The operative features involved are those of an ordinary posterior or anterior gastrojejunostomy (q. v.). The question of an accompanying jejunojejunostomy is the same as in the gastro-enterostomy operations. The general procedure is suggested in Fig. 3513.



Figs. 3511 and 3512.—Operation for Hour-glass Stomach by Anterior Gastrogastrostomy: _ a, Lines of incision to be made into the clamped cardiac and pyloric pouches, in the transverse axis of the stomach; _ b, the anastomosed pouches

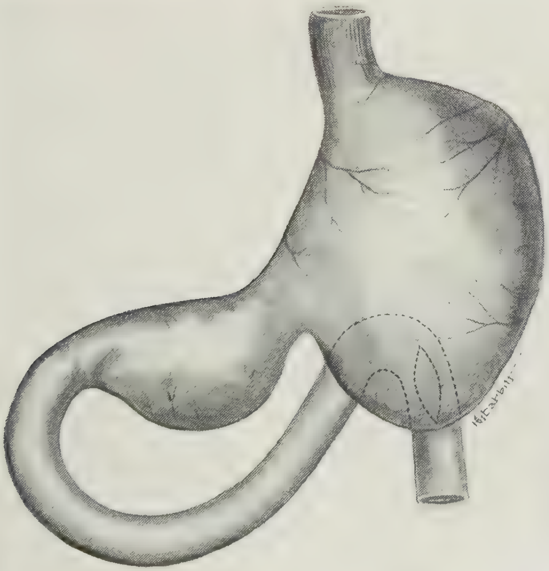


Fig 3513.—Operation for Hour-glass Stomach by Posterior Gastrojejunostomy.

Operation for Hour-glass Stomach by Posterior Gastrojejunostomy with the Pyloric Pouch _ and Accompanying Gastrogastrostomy Between Cardiac and Pyloric Pouches.—When there is necessity to relieve stagnation in the pyloric pouch as well as in the cardiac pouch, a posterior gastrojejunostomy may be made between the nearest available part of the jejunum and the posterior aspect of the pyloric pouch – after which the two pouches may be anastomosed by the Woelfler, or Kammerer-Finney gastrogastrostomy method (q. v.). The completed operation is shown, diagrammatically, in Fig. 3514.

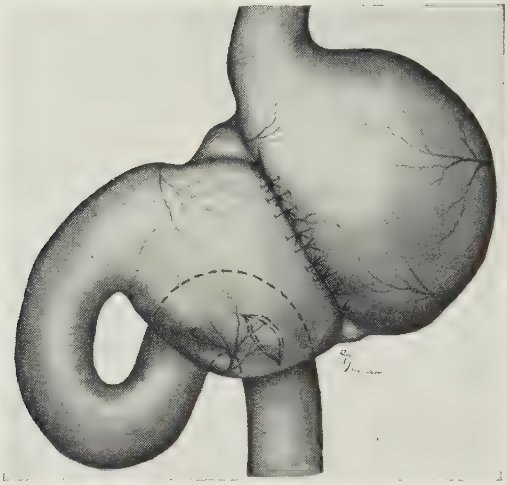


Fig. 3514.—Operation for Hour-glass Stomach by Posterior Gastrojejunostomy with the Pyloric Pouch – and Accompanying Gastrogastrostomy Between the Cardiac and Pyloric Pouches.

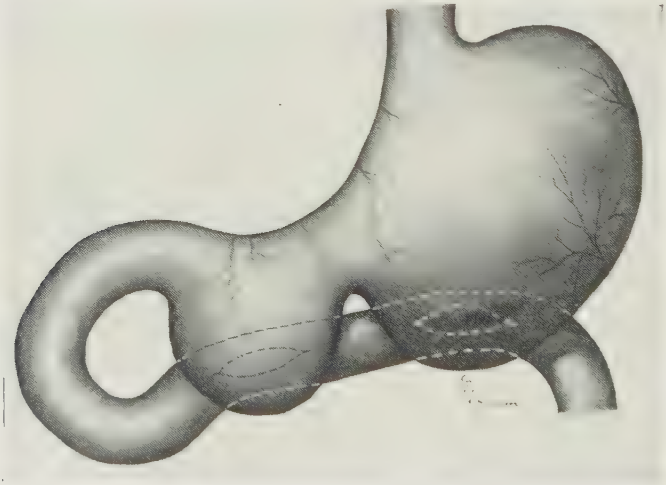


Fig 3515.—Operation for Hour-glass Stomach by Double Posterior Antiperistaltic Gastrojejunostomy with Cardiac and Pyloric Pouches – (Weir and Foote).

Operation for Hour-glass Stomach by Double Anterior or Posterior Gastrojejunostomy with Cardiac and Pyloric Pouches (Weir-Foote Operation).—This method has been resorted to where it was necessary to provide for the drainage of both cardiac and pyloric pouches. Such conditions, however, are probably better met by other methods of procedure. When the above technic is adopted the posterior anastomosis (Figs. 3515 and 3516) is preferable, where it can be carried out — otherwise the anterior anastomosis may be performed.

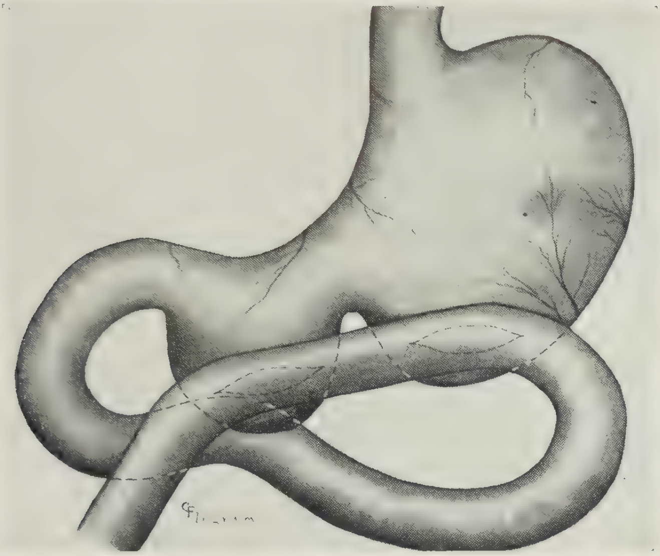
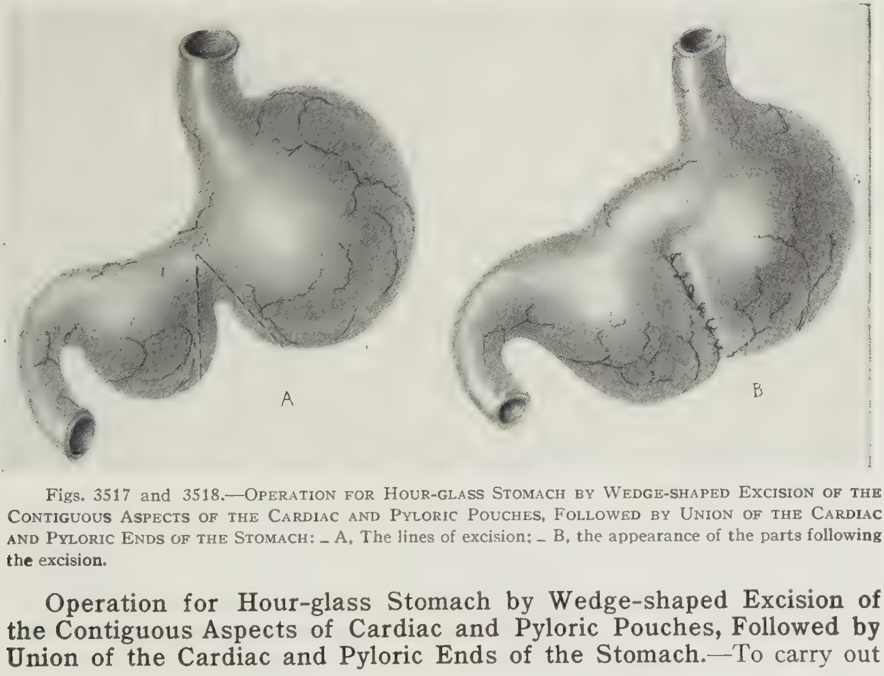


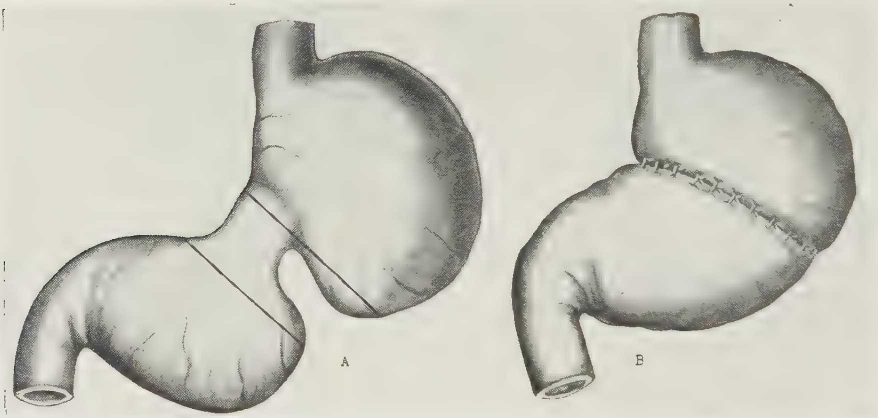
Fig 3516.—Operation for Hour-glass Stomach by Double Posterior Isoperistaltic Gastro jejunostomy with Cardiac and Pyloric Pouches — (Weir and Foote).



Figs. 3517 and 3518.—Operation for Hour-glass Stomach by Wedge-shaped Excision of the Contiguous Aspects of the Cardiac and Pyloric Pouches, Followed by Union of the Cardiac and Pyloric Ends of the Stomach: — A, The lines of excision; — B, the appearance of the parts following the excision.

Operation for Hour-glass Stomach by Wedge-shaped Excision of the Contiguous Aspects of Cardiac and Pyloric Pouches, Followed by Union of the Cardiac and Pyloric Ends of the Stomach.—To carry out this procedure it is necessary that the posterior wall of the stomach be mobilizable _ and the technic is more appropriate when the sulcus between the saddlebags is not very deep. The line of excision is shown in Fig. 3517 _ and the stomach, after the excision, in Fig. 3518. Anterior and posterior walls are included in the excision.

Operation for Hour-glass Stomach by Excision of the Middle Portion of the Stomach, Followed by Union of its Cardiac and Pyloric Ends.—The chief indication for this extensive procedure is the presence or suspicion of cancer in the area of contraction, or of an obstinate, progressive ulcer. Ability to sufficiently mobilize the stomach for the needed manipulations is essential. The steps of the technic are the same as those to be described under the Excision of the Middle Third of the Stomach for Cancer (p. 381). The involved region is clamped off _ as shown in Fig. 3519, A. The completed operation is seen in Fig. 3520, B. Sometimes the pyloric aspect of the stomach is excised, followed by a gastroduodenostomy (p. 357).



Figs. 3519 and 3520.—Operation for Hour-glass Stomach by Excision of its Middle Third, Followed by Gastrogastrostomy: _ A, Lines of excision; - B, the cardiac and pyloric ends sutured together.

Operation for Hour-glass Stomach by Divulsion.—This is an application to hour-glass constriction of Loreta's principle of digital dilatation of pyloric constriction (p. 260). It is of limited use _ but Burghard speaks of having successfully employed the method in a case of a stomach involved by tumor at the site of the isthmus, and extensively adherent to the abdominal wall anteriorly, and to the pancreas posteriorly, making operation impossible. He inserted a single finger, and added a second, third, and fourth _ passing through the constriction from the pyloric to the cardiac pouch, by inward pouching of stomach wall. Patient well several years later _ tumor gone.

GASTRO-ENTEROSTOMY, IN GENERAL

By gastro-enterostomy is meant the establishment of an anastomotic opening between the stomach and some part of the small intestine _ the name of the operation being further designated by the part of the intestine anastomosed _ for example, gastroduodenostomy, gastrojejunostomy, gastro-ileostomy. The object of the operation is generally to obtain the complete emptying and rest of the stomach _ or to furnish egress from it in cases of obstinate obstruction at or near the pyloric end _ or in cases of excision of the pylorus, or of the intestine near the pylorus.

The nearer to the stomach the portion of intestine anastomosed, the greater will be the length of small intestine left for absorption. That portion of the stomach between the pyloric end and the site of the intestine anastomosed with the stomach becomes partially thrown out of circuit ("short-circuited") in proportion as it continues, or not, to transmit intestinal contents, and henceforth performs more or less limited function _ the bulk of the stomach contents traveling by the new route, while the small amount which escapes through the pylorus still goes by the old route.

The flow of the stomach contents is usually from the cardiac to the pyloric and along the greater curvature, nearer which the anastomosis is generally made _ and usually from the pyloric to cardiac end along the lesser curvature. It is always desirable to so approximate a coil of intestine to the stomach that the flow in both viscera may be in a normal direction _ which is generally accomplished by giving the coil of intestine a half-turn just before making the anastomosis.

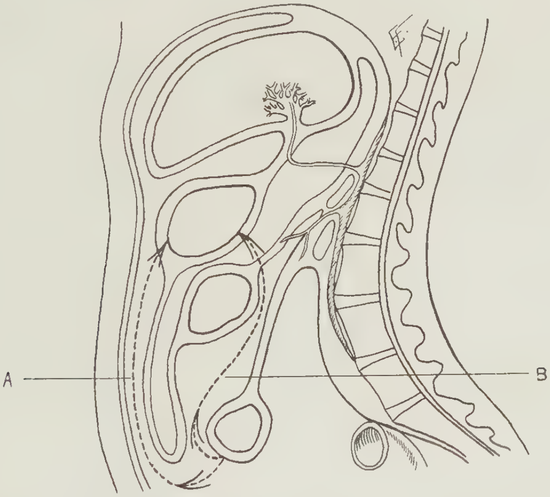


Fig. 3521.—Diagram Representing Gastro-enterostomies: _ A, Anterior gastro-enterostomy _ small intestine being carried over omentum and applied to anterior stomach wall; B, posterior gastro-enterostomy _ small intestine being carried through an opening made in transverse mesocolon and applied to posterior stomach wall. (Modified from Gray.)

In order to avoid regurgitation into the stomach of intestinal contents, including bile, most Surgeons, after completing the gastro-enterostomy, perform a jejunojejunostomy (between the proximal and distal limbs of the jejunum) _ the Jaboulay-Braun operation (see page 302).

The intestine may be anastomosed to the anterior or to the posterior wall of the stomach _ constituting anterior or posterior gastro-enterostomy (Fig. 3521). The latter operation is preferable _ the reasons for which being given under Comment upon the two operations, pages 308 and 321.

The duodenum may also be anastomosed to the stomach, constituting gastroduodenostomy.

The portion of the small intestine generally employed for approximation to the stomach is the jejunum _ and, therefore, where this portion of the small intestine is used, the designations, anterior and posterior gastrojejunostomy, are more specific.

Indications for Gastro-enterostomy.—As condensed from the excellent summary of this subject by Burghard: – (*A*) **In the Following Cases of Gastric or Duodenal Ulcer:** – (*a*) Perforating ulcer of the pylorus or duodenum, where closure of the site of ulceration would too greatly narrow the exit for food; – (*b*) Perforating gastric ulcer associated with other ulcers near the pylorus which are either apt to perforate, or cause harmful constriction in healing; – (*c*) Perforating ulcer of the isthmus of an hour-glass stomach, whose healing will dangerously narrow the isthmus; – (*d*) Recurrent, increasing hemorrhage from chronic gastric or duodenal ulcers; – (*e*) Prepyloric or pyloric chronic ulcer – unless, in the case of multiple ulcers, excision of the ulcer-bearing region is preferable; – (*f*) Fibrous stricture at or near the pylorus, occurring in connection with a healed ulcer; – (*g*) Perigastritis and periduodenitis where adhesions, due to ulcers or to cholecystitis, prevent satisfactory emptying of the stomach; – (*h*) Cases of obstructed pylorus or duodenum due to the ulceration of biliary calculi through from the gall-bladder; – (*i*) In hour-glass stomach with constriction near the pylorus (where the anastomosis is made in the cardiac pouch of the stomach) – or in hour-glass stomach where gastroplasty has been performed (in which cases the anastomosis is made in the pyloric pouch of the stomach). (*B*) **In Carcinoma of the Stomach or of the Duodenum** – where the tumor is causing obstruction and cannot be removed. Also, as a preliminary to the radical operation, in some cases of gastric carcinoma, where the tumor can be excised to improve nutrition. (*C*) **Congenital (Infantile) Hypertrophic Stenosis of the Pylorus** – the choice lying between gastro-enterostomy and pyloroplasty. (*D*) **In Cases of Corrosion of the Gastric Mucosa from Chemicals.** If only the pyloric region be involved, gastro-enterostomy must be performed – and may be advantageously associated with temporary gastrostomy. (*E*) **In Some Cases of Acute Gastric Dilatation** – in connection with obstruction at, or near the pylorus – or of the duodenum, where the superior mesenteric vessels cross.

Contraindications for Gastro-enterostomy (Burghard).—All states and conditions in which there is no demonstrable organic cause for the phenomena which the operation would be undertaken to relieve. He condemns it in all cases of atonic dilatation and of gastroptosis.

Preparation – Position.—As in Gastrotomy (p. 238).

Anesthesia.—The operation is generally of sufficient complexity and duration to make anesthesia preferable to analgesia.

ANTERIOR OR PRECOLIC GASTROJEJUNOSTOMY (WOELFLER), FOLLOWED BY JEJUNOJEJUNOSTOMY (BRAUN)

Description.—A loop of jejunum, about 40.5 to 45.5 cm. (16–18 inches) from the duodenojejunal angle, is brought up in front of the great omentum and transverse colon, and sutured to the lower aspect of the anterior wall of the stomach, parallel with the greater curvature, forming an anterior gastrojejunostomy, – after which the inner aspects of the lower parts of the two limbs of the jejunal loop are generally, though not invariably, anastomosed, constituting a jejunojejunostomy. The operation is performed, as explained under General Surgical Considerations (p. 300), for the relief of some mechanical obstruction to the satisfactory emptying of the stomach. Anterior gastro-enterostomy is only a second choice, when the otherwise preferable no-loop posterior gastro-enterostomy may be contraindicated, because of such conditions as disease of the posterior aspect of the stomach; extensive adhesions; congenital deformity, with very short mesocolon; or in the presence of other mechanical difficulties. Both operations are here done by simple suturing, though either, or both, may be done by the Murphy button.

Originally it was a matter of importance to attach an isoperistaltic loop of small intestine to the anterior stomach wall (by giving the coil of intestine a half-turn, before suturing it to the stomach) – so as to cause the peristaltic waves of stomach and intestine to coincide – and thus prevent the accumulation of stomach contents between the pylorus and the site of attachment and intestine. Now, however, by resorting to an entero-enterostomy (jejunostomy) at about 7.5 cm. (3 inches) from the stomach (at the lower level of the two limbs of the jejunum which have passed upward to form the loop, whose apex is sutured to the stomach), the features of the "vicious circle" are avoided. The free passage of gastric contents is further aided by the addition of Hartmann's modification of Kappler's technic – which is the suturing of the loop of jejunum to the stomach wall somewhat laterally beyond each side of the immediate anastomotic opening of intestine and stomach, so that the loop will not tend to be drawn in to a sharp ∧, through which the exit of stomach contents would be difficult.

Preparation.—The stomach is usually lavaged daily, several days in advance, and again just before the operation, – and the bowels emptied by purgation. The site of operation is shaved.

Position.—The patient is supine, at the side of the table, with the abdominal parietes relaxed by slight elevation of the shoulders and slight flexion of the hips. The Surgeon usually stands to the right – and the Assistant, upon the opposite side of the table.

Landmarks.—Ensiform cartilage; umbilicus; linea alba; right semilunar line.

Incision.—Vertical, from 10 to 12.5 cm. (4–5 inches) in length, placed about 2 cm. ($\frac{3}{4}$ inch) to the right of the median line – extending from the costal arch downward. A median incision is cometimes employed. An oblique incision, parallel with the right costal arch, which has been sometimes used, is more destructive of the abdominal musculature, although furnishing a freer access in special cases.

Operation.—The steps of the operation, up to the opening of the peritoneal cavity, are conducted as in the operation of abdominal section by a paramedian incision (p. 130).

The beginning of the jejunum is now sought – and is most readily found by temporarily displacing the great omentum upward and to the left, and the transverse colon and mesocolon upward and to the right – and by following down the under surface of the mesocolon to its base, from left to right, as the finger passes beneath the ligament of Treitz, a loop of small intestine is encountered, which is the commencement of the jejunum. This is now followed down several inches until a convenient distance for anastomosis, without tension, to the anterior stomach wall is secured – which is generally about 40 to 50 cm. (16–20 inches). This site of jejunum being held by an Assistant, the transverse mesocolon and great omentum are now allowed to drop back into place – the jejunum being brought down, around and in front of them – seeing that sufficient length of intestine for this course is allowed. It is important that this displacement of the jejunum should be accomplished without undue twisting and tension of the intestine, or marked disarrangement of the normal relations of the parts concerned, other than that necessitated by the technic.

Remembering which is the proximal and which the distal end of the loop of the isolated loop of jejunum – and "milking" away its contents to either side of its summit – the proposed site of anastomosis of the anterior stomach wall and the corresponding portion of the jejunum should be drawn somewhat out of the abdominal cavity, for the greater convenience of manipulation. The surfaces to be anastomosed are approximated by a triple-bladed gastroenterostomy clamp. From 7.5 to 10 cm. (3–4 inches) of the loop of jejunum (from which the contents have been pressed) are seized between the lowermost and middle blades of the clamp. A corresponding portion of the anterior aspect of the lowest portion of the greater curvature of the stomach is seized between the uppermost and middle blades of the clamp (Fig. 3522). The position of the clamps grasping stomach and intestines should be oblique, from above downward, and toward the right — more or less parallel with the lesser curvature of the stomach — and with the tips of the clamps lying in the general direction of the pyloric end of the stomach and the distal aspect of the intestinal loop. It is sought to seize the lowest site of the greater curvature of the stomach, which corresponds, approximately, with a vertical line let fall from the right wall of the esophagus. (Where special stomach-clamps are not available, an Assistant holds the antimesenteric aspect of the jejunal loop in easy contact with the lower anterior surface of the stomach wall, opposite the

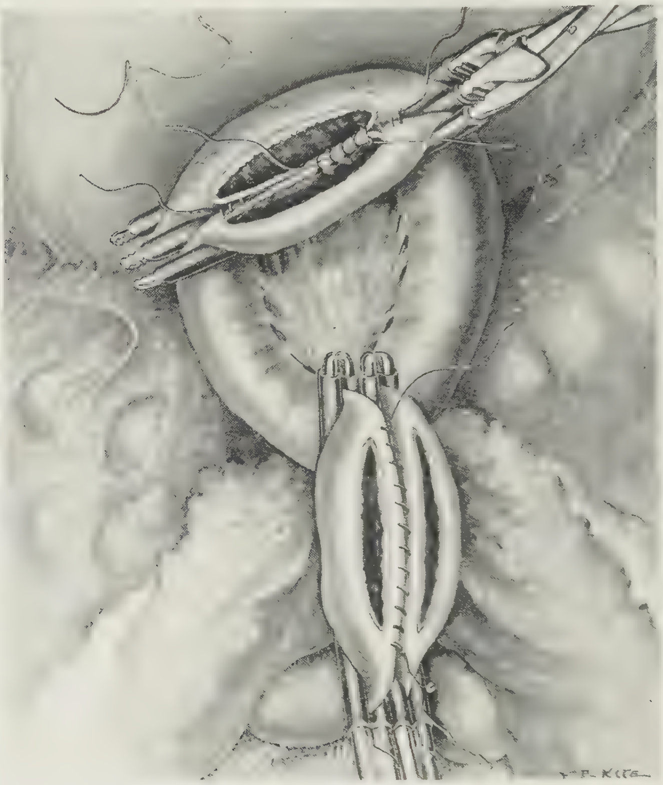


Fig. 3522.—Anterior or Precolic Gastrojejunostomy (Woelfler) — Followed by Jejunojejunostomy (Braun) — I; — The approximation, by triple clamp, of the jejunal loop to the anterior stomach wall, near the greater curvature — constituting the gastrojejunostomy. The posterior seromuscular suture of the gastrojejunostomy has been applied — the gastric and jejunal walls have been incised — and the posterior marginal suture has been begun. The approximation, by separate clamps, of the antimesenteric aspects of the ascending and descending limbs of the jejunal loop — constituting the jejunojejunostomy. The posterior tier of seromuscular suturing alone has been here placed. The jejunal walls have been axially incised, opposite each other, within the clamped-off areas. The steps of the two separate operative technics are here shown concurrently for convenience

lowest portion of the greater curvature _ holding the stomach so as to exclude, as much as possible, an outflow of its contents when incised _ the intestinal loop being squeezed empty and then controlled by ordinary clamps.) The rest of the viscera are now returned to the abdominal cavity, and the site of operation well walled off with taped and numbered gauze pads. Strips of gauze may also be carried between the blades of the clamps and wrapped around their handles. All that appears in the wound are the clamped viscera, the clamps, and the gauze pads.

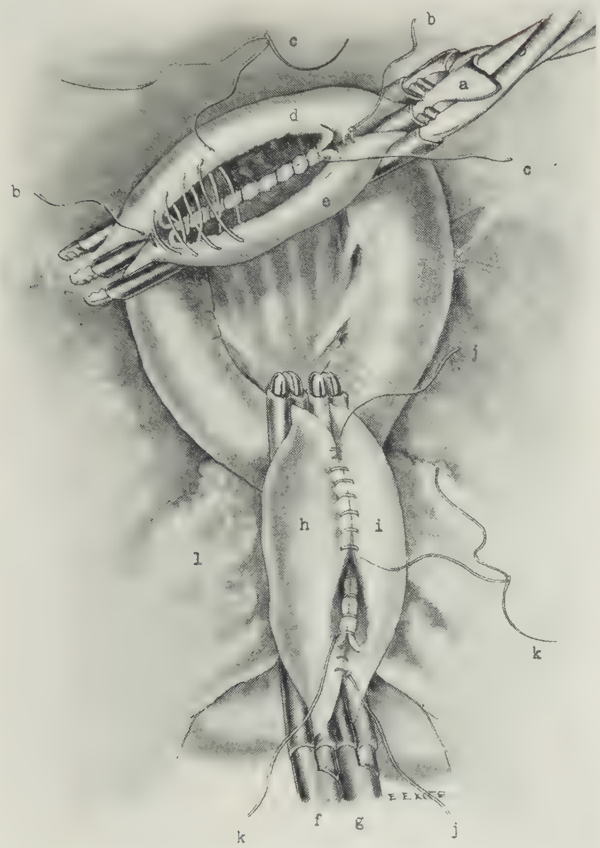


Fig. 3523.—The Same _ II: _ **b, b,** The posterior seromuscular suture of the gastrojejunostomy; _ **c, c,** marginal suture of the gastrojejunostomy _ its posterior portion having been placed, and its anterior portion (the anterior marginal suturing) seen in progress; _ **a,** triple clamp approximating the isolated portion of stomach wall, **d,** and the jejunal loop, **e.**

g, Clamp of the proximal limb of the jejunal loop, I: _ **f,** clamp of the distal limb of the jejunal loop, **h,** _ **j, j,** posterior seromuscular suture of jejunojejunostomy _ its upper end being ready to round into the anterior tier of the seromuscular suture after the marginal suture is completed; _ **k, k,** marginal suture _ the portion represented by the lower **k,** having been placed _ and that represented by the upper **k,** in the act of being placed; _ **l,** lower border of the omentum, folded upward to enable the jejunal loop to be brought forward.

Fine Pagenstecher linen thread, carried upon a curved intestinal needle, held in a needle-holder, is employed _ while the part of the intestine to be pierced is steadied by forceps, which are shifted with each needle puncture _ the suturing being of the continuous type, in two or in three tiers. The first or outlying tier is of the seromuscular coat of the stomach, on the one hand, to the seromuscular coat of the jejunum, on the other, approximating surface to surface. Upon the first passage of the needle, the suture is tied, with the free end left long – after which the suture is run, continuously, to the other end of the site of anastomosis, where the long end of the suture is left threaded (as shown in the illustration last quoted). The serosa and muscularis of stomach and intestines are now incised with a sharp knife, in a slightly elliptic fashion, over the clamped region – the incisions not extending quite as far as the limits of the outer suturing, and care being taken that the mucosa is not penetrated. The inner tier of continuous suturing of the cut margins of the serosa and muscularis is placed – the first step of suturing being knotted, with the free end left long, and the long end left threaded at the end of the line (Fig. 3523). The double line of posterior suturing is thus completed – extending, at both ends, for about 1.2 cm. (½ inch) beyond the limits of the future incision through the two opposed walls.

With a sharp-pointed bistoury a quick controlled stab is made through the mucosa into the clamped portion of the stomach and intestine, in the indicated sites, and so planned that the incisions will fall immediately opposite each other and be of the same size – the incisions being made while both stomach and intestine are so held by an assistant as to present their proper surfaces, and at the same time the opposite walls are held apart so as not to be also penetrated by the knife stab. One blade of a pair of sharp-pointed scissors is now introduced, and both incisions lengthened in the long axes of the clamped surfaces, to the extent of about 5 to 6.5 cm. (2–2½ inches) – until within about 1.2 cm. (½ inch) of either end of the posterior line of suturing. These incisions into the lumina of the stomach and intestine, made immediately opposite each other, should be at least from 5 to 8 mm. (¼–⅓ inch) from the suture line. Soiling of the adjacent structures with the outflow of stomach and intestinal contents should be prevented as much as possible with gauze packing. All bleeding should be controlled by clamping and twisting – and is further controlled by suturing – and by gut ligature if necessary. Immediately following these incisions a third tier of catgut sutures is carried continuously through and around the margins of cut mucosa. The needle threaded to the tier of sutures through the cut margins of serosa and muscularis is now taken up and carried on around through the cut margins of the remaining half of these incised intestinal coats, and knotted. The needle threaded to the outlying suture, passing through the serosa and muscularis, and approximating the surfaces of gastric and intestinal serosæ, is then taken up – and a similar line of suturing carried around the second side, and knotted. In this way the borders of the mucosa are sutured together, the margins of the cut serosa and muscularis, of stomach and intestines, are approximated – and, the outlying line of sutures, uniting the serous surfacesao stomach and intestine, are completed. During the suturing of the opening the outflow of contents from the hollow viscera is prevented as far as possible, and that which does come out is at once caught by gauze. The Mayos advise the third tier of sutures through the borders of the mucosa in anterior gastrojejunostomy – applying it especially to the posterior lips of the cut mucosa, to control bleeding from the posterior suture line (for which they have had to reopen the abdomen). In the majority of instances it is probable that but two lines of sutures are used, – the outlying one, including the serosa and muscularis of stomach and intestine, – and the inner one, including the cut margins of the serosa muscularis, and mucosa of stomach and intestine.

In completing the operation it is well to adopt Hartmann's modification of Kappler's technic _ which consists in suturing with linen (some Surgeons preferring chromic catgut) the jejunum to the stomach by two mattress-sutures, one on each side, placed about 2.5 to 3.8 cm. (1–1½ inches) beyond the gastro-enterostomy sutures (Fig. 3524). This attachment nearly doubles the length of approximation of the intestine to the stomach, thereby keeping the gastro-enterostomy opening greater and more patulous, and largely preventing angulation of the two limbs of the loop _ thereby providing for the free emptying of the stomach. The Mayos state that the adoption of this technic has prevented the unfortunate mishaps which formerly so often accompanied the operation, and for which the accompanying jejunojejunostomy was so frequently made part of the completed technic. The completed operation is shown in Fig. 3524.

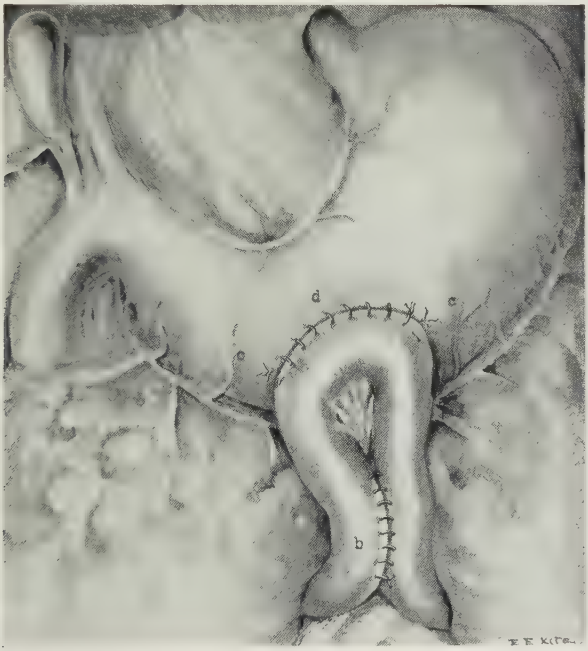


Fig. 3524.—The Same _ III; _ The completed gastrojejunostomy and jejunojejunostomy. Hartmann's modification of Kappler's technic is shown _ where the approximation of the jejunal loop to the anterior stomach wall is considerably extended, laterally, by two mattress-sutures of gut.

When the operation is finished the clamps are relaxed, the structures returned to the peritoneal cavity, and the abdomen closed in the usual manner _ in those cases in which no further procedure is to be added to the chief operation.

Where, however, the Braun or Jaboulay-Braun technic _ jejunojejunostomy _ is to be made a part of the general procedure (and it makes the operation more complete, and safer, to do so), the two limbs of the jejunum are clamped at a convenient distance below the site of anastomosis (usually about 7.5 cm., or 3 ins.) from the stomach (after pressing their contents from the region) _ by means of a single clamp, two single clamps, or a triple clamp _ in such a manner as to conveniently approximate their antimesenteric borders. The steps of the jejunojejunostomy are, practically, the same as those just described for the gastrojejunostomy _ either an outlying line of continuous sutures through serous and muscular coats of the two coils, followed by the division of these coats and the suturing of their margins, and then the division of the mucosa and the suturing of its margins (three tiers of suturing) – or the seromuscular suture just described, followed by incising all the intestinal coats, with the suture of their margins (two tiers of suturing).

Finally, the viscera are returned within the cavity, and the abdomen closed as in the paramedian abdominal section.

Comment.—The chief objections to the anterior method of gastro-enterostomy are – that the transverse colon is apt to be compressed by the small intestine resting and dragging upon it; – that the two intestinal arms descending from the stomach are apt, by gravity and traction, to become parallel, and a spur formation thereby occur at the stomach opening, by converting the original curve at their point of meeting into an angularity; – and that regurgitation of intestinal contents, including bile, into the stomach is more frequent after the anterior operation. Therefore various suggestions have been made to overcome the above disadvantages – such as valvular forms of anastomoses, – multiple intestinal anastomoses, or a single intestinal anastomosis, to carry off the contents of the proximal end of the intestine, including bile, – and, probably best of all, posterior gastro-enterostomy.

In all forms of gastro-enterostomy, but especially in the anterior operations, it is advisable, after completing the gastro-enterostomy proper, to form an intestinal anastomosis, a jejunojejunostomy, at the site and in the manner just described (p. 307) and pictured in Figs. 3524 and 3525.

In the operation just described, wherever the continuous suture is used, it is well to tie it at several points (without intermitting the stitch) rather than at one only – to do away with any possibility of the suture acting as a "draw-string" and constricting the opening.

In the operation performed as above the proximal end of the anastomosing loop of the intestinal loop was usually placed toward the left, and the distal end toward the right. The Rockwitz technic, formerly so often employed, of giving the jejunum a half-turn before approximation, to cause the flow in the intestinal canal to correspond with the gastric flow, is now often omitted because of the jejunojejunostomy which is usually made a part of the main operation – though additional safety is secured by its adoption, even though the jejunojejunostomy be employed.

Especial care is exercised that the surrounding seromuscular suture outlies the inner marginal suture by a sufficiently broad surface of serosa for adhesion, so that protection from leakage will be satisfactory.

It is better not to have the opening in the jejunum to accurately correspond with its antimesenteric aspect – but somewhat nearer that aspect of the jejunum which will be approximated to the stomach, for in this way the surface of the intestine will lie more flatly against and apply itself better to the anterior wall of the stomach.

See that the transverse colon and omentum are left as normally placed as the circumstances of the operation permit. The proximal limb of the jejunum tends to constrict the transverse colon.

To quote from Balfour, in the Mayo Clinics, as to the indications for anterior gastro-enterostomy: – "It is generally conceded that when a gastro-enterosotomy is indicated, the posterior no-loop operation is safer, gives the best end-results, and that it carries practically no risks of unfortunate mechanical sequelæ. The method has been so consistently satisfactory that it may have been used at times when other methods would have sufficed as well, or perhaps better. It is particularly applicable for benign lesions in the region of the pylorus when the resection of the pyloric end of the stomach is not indicated, or some type of plastic operation is not possible. For various reasons an anterior gastro-enterostomy is the operation of choice in certain definite groups of cases, the largest of which is composed of the obstruction at the pylorus due to carcinoma in which a resection of the growth is not feasible. In many of these cases the mechanical obstruction, with retention of decompose dfood products and the resulting starvation, are the important factors. These patients are not only greatly relieved temporarily by drainage of the stomach, but the terminal stages of the malignancy are much less pitiable.

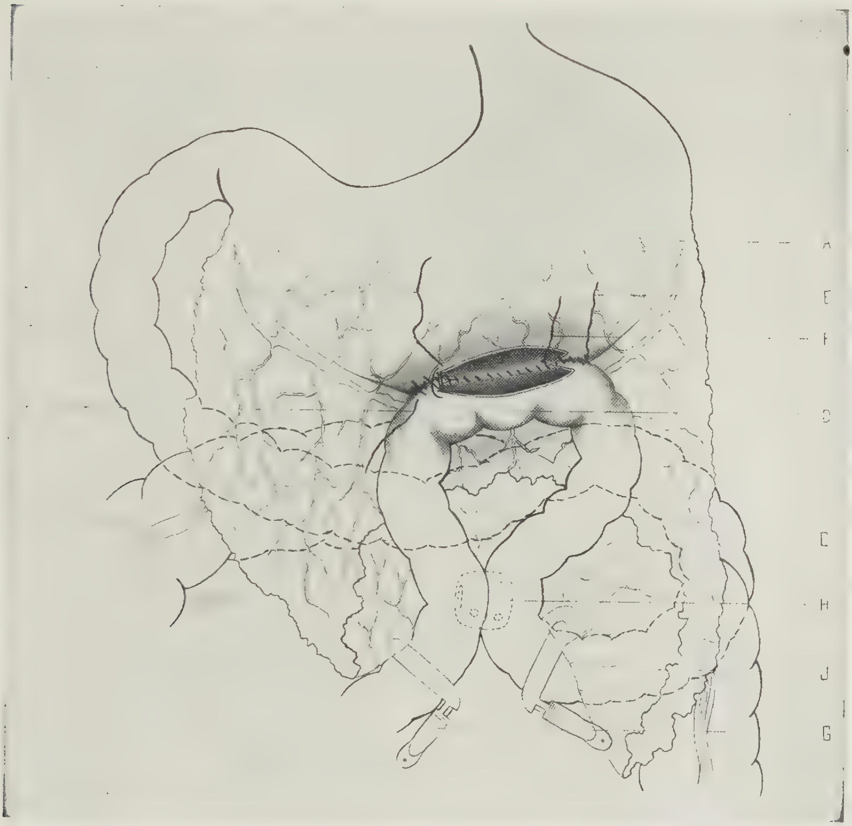


Fig. 3525.—Anterior Gastro-enterostomy by Simple Suturing, Followed by Jejunojejunostomy by the Murphy Button: _ A, Stomach; B, duodenum; C, jejunum, after emerging from ligament of Treitz; D, coil of jejunum given a half-turn and applied to lower aspect of anterior stomach wall; E, E, outer tier of continuous Lembert suturing; F, F, inner tier of continuous overhand suturing approximating edges of opening in stomach and intestine; G. intestinal clamps; H, entero-enterostomy by Murphy button I, transverse colon; J, omentum folded back by uplifted jejunum.

It is particularly in this type of cases that the anterior method is preferable on account of the speed, safety, and simplicity with which it can be performed. A smaller group of cases is composed of certain benign lesions at or near the pylorus where a posterior gastro-enterostomy would be desirable, but not possible, because of the presence of certain mechanical conditions. Extensive adhesions, congenital or inflammatory, malformations, etc., may be sufficient to preclude the advisability of attempting the posterior method, and yet permit the anterior operation to be done safely and quickly."

Kocher even considers the anterior operation the one of choice.

After having performed the gastrojejunostomy by simple suturing as above described, the accompanying jejunojejunostomy may be accomplished by means of the Murphy button (instead of by simple suturing, as just described, Fig. 3524). Or both the gastrojejunostomy and the jejunojejunostomy may be performed by the Murphy button. The technic of these procedures with the button will be described under Posterior Gastrojejunostomy (p. 324) — the steps, in so far as the use of the buttons is concerned, being the same.

A modified and simplified manner of using the Murphy button is shown in Figs. 3526 and 3527.

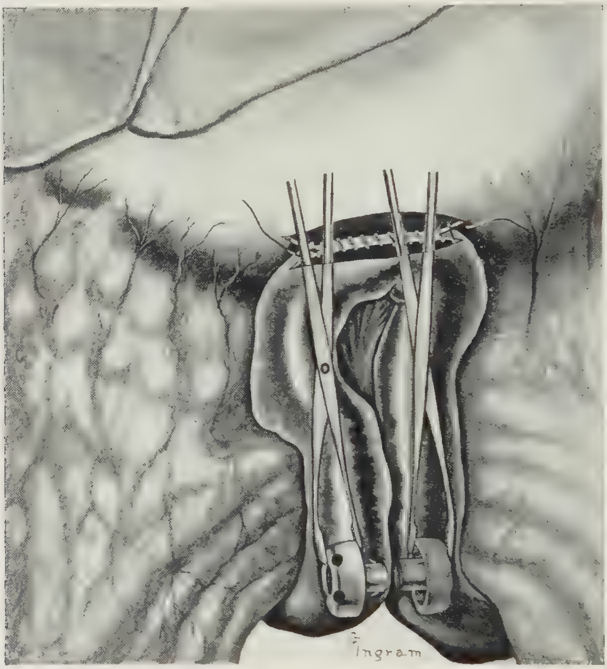


Fig. 3526.—Anterior Gastrojejunostomy by the Murphy Button — Followed by Jejunojejunostomy by Gallet's Method of Introducing Weir's Modification of the Murphy Button; — Through the partially sutured and still open jejunal loop, the male and female buttons are carried down in the grasp of long forceps, one button into each jejunal loop — the male button into the proximal loop — and the female button, into the distal loop — preparatively to approximating them, by pressing the sharpened flange of the one through both intestinal walls and into the lumen of the other. Finally, the gastrojejunal opening will be closed in the usual manner.

In Fig. 3528, A is shown the incorrect manner of anastomosing the loop of the jejunum to the anterior stomach wall, when no accompanying jejunojejunostomy is to be performed for then the stomach contents which pass out through the pylorus (and, unless there be complete obstruction, some contents continue to pass the pylorus) tend to stagnate in and weigh down that portion of the duodenum and jejunum between the pylorus and the site of the gastrojejunostomy. The correct manner of making a half-turn of the jejunum before applying it to the anterior stomach wall is shown in Fig. 3529, B, where an isoperistaltic relationship between stomach emptying and intestinal transit is seen.

Absorbable sutures should always be used in the through-and-through

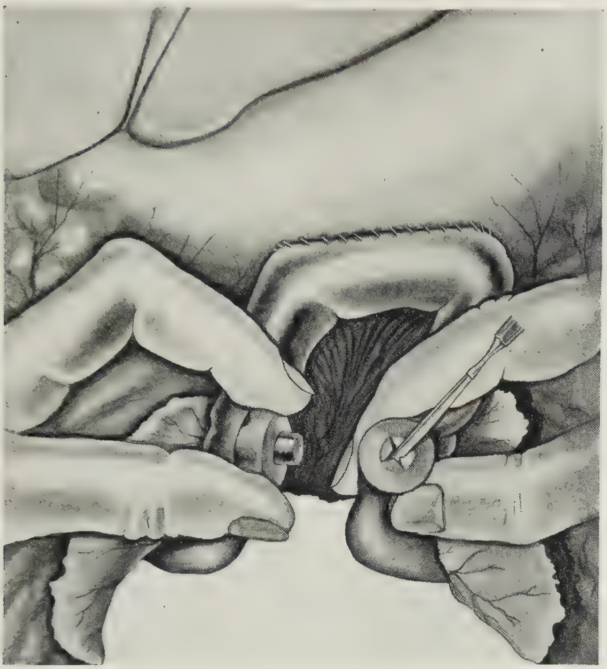
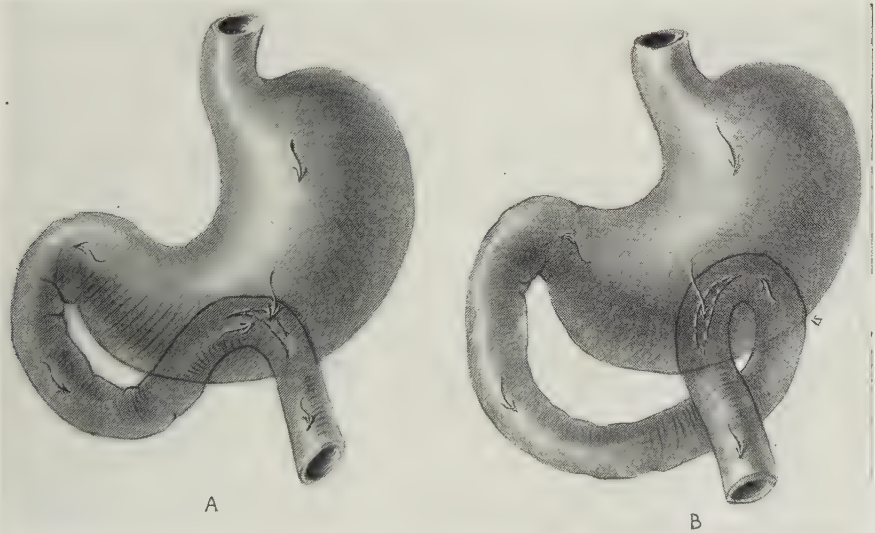


Fig. 3527.—Anterior Gastrojejunostomy by the Murphy Button – Followed by Jejunostomy by Hartley's Method of Introducing and Approximating the Buttons; – Before the closure of the gastrojejunostomy opening the female button is dropped into the proximal jejunal limb of the loop and the male button into the distal limb – after which they are approximated through crossed incisions made over their cylinders



Figs. 3528 and 3529.—The Vicious Gastro-intestinal Circle and the Manner of Avoiding it: – A, The incorrect or non-isoperistaltic method of approximating the jejunal loop to the anterior stomach wall, when no jejunojejunostomy is simultaneously performed. Accumulation of stomach contents in the proximal limb of the loop between the pylorus and the site of anastomosis is due to occur. B, The correct or isoperistaltic manner of making a half-turn of the jejunum in anastomosing the intestinal loop with the anterior stomach wall.

marginal stitch of all gastro-enterostomies, owing to the frequent finding of non-absorbable suture material in contact with ulcers.

POSTERIOR OR TRANSCOLIC GASTROJEJUNOSTOMY BY THE NO-LOOP METHOD

Description.—In this, the now more frequently performed and generally preferable type of gastro-enterostomy, the upper part of the jejunum, as near the duodenojejunal junction as possible, is carried through an artificial opening, made for the purpose, in the transverse mesocolon, and anastomosed with the posterior wall of the stomach, constituting a posterior gastrojejunostomy. The object of the operation is, as explained under General Surgical Considerations, p. 300, to provide for the relief of some mechanical obstruction to the satisfactory evacuation of the gastric contents _ and is usually considered the operation of choice (where the posterior stomach wall is available), and preferable to the anterior operation _ as it affords better gastric drainage _ does not unnaturally cross the course of the transverse colon _ "vicious circle" less often occurs _ and peptic ulcer and internal hernia less frequently follow. Further comments are made in this connection, under Description and under Comments, in Anterior or Precolic Gastrojejunostomy, p. 308. As there is no loop, no accompanying jejunojejunostomy is performed. The operation may be performed by the antiperistaltic technic (as here described) _ or by the isoperistaltic technic (as described under Comments).

Preparation _ Position _ Landmarks.—As in the anterior operation.

Incision.—A paramedian incision, about 2 cm. ($\frac{3}{4}$ inch) to the right of the linea alba, is made vertically downward, from the right costal arch, for 10 to 12.5 cm. (4–5 inches). A median incision is sometimes employed. The oblique subcostal incision is not desirable, owing to the damage to the musculature.

Operation.—The incision passes through skin, fascia, and anterior sheath of the right rectus muscle _ the inner portion of the split sheath is retracted inward, toward the median line _ while the inner part of the muscle is drawn outward _ after which the posterior rectal sheath and peritoneum are incised to correspond with the anterior incision _ and the peritoneal cavity entered _ as in paramedian abdominal section (p. 130). Instead, the fibers of the rectus are sometimes split, but it leaves a stronger abdominal wall to retract the muscle. On entering the abdomen, a thorough investigation should be made of the abdominal contents _ especially of the viscera to be involved in the anastomosis, and of the gall-bladder tract, as well as of the environment generally _ to determine the condition of the parts, and to decide upon the steps of the main and whatever collateral operations may be necessary.

The wound margins are well retracted and the involved viscera delivered as far out of the abdomen as possible _ the great omentum being displaced upward and somewhat to the left, and the stomach, with the transverse colon now above and over it, upward and somewhat to the right _ thus exposing the under surface of the transverse mesocolon. In this position of the displaced parts, it is easy to locate the duodenojejunal flexion and the upper part of the jejunum _ by following down the under surface (or what is normally the under surface) of the mesocolon from left to right _ until the finger, passing down beneath the ligament of Treitz, encounters a loop of small intestine, which is the beginning of the jejunum _ and may be hooked up upon the finger (Fig. 3530). The ligament of Treitz and its peritoneal covering are developmentally different in different individuals _ and its condition is important in posterior gastrojejunostomy, for it is just below (distal to) this ligament that the axial incision in the jejunum is made (Fig. 3531). In some it is very short, and in others it has been found as much as 6 cm. (2$\frac{6}{16}$ inches) long, and with a tendency to turn the jejunum to the right (Fig. 3532, **a**). In those cases where its length and direction interfere with the technic of the operation, it is better to divide the ligament, or its peritoneal reflection at their attachment to the jejunum (Fig. 3533, **b**) – thereby providing better approximation of the beginning of the jejunum to the posterior stomach wall, and its more normal trend toward the left. The raw surface left from this division will be taken care of in the anastomosis, when stomach and jejunum are folded together – the axial jejunal incision passing through part of the denuded surface (as shown in the illustration) – and the margins of the denuded surface upon the transverse mesocolon not so protected in the subsequent steps of the operation, may be sutured together. The jejunum is directed to the right chiefly by the peritoneal reflection.

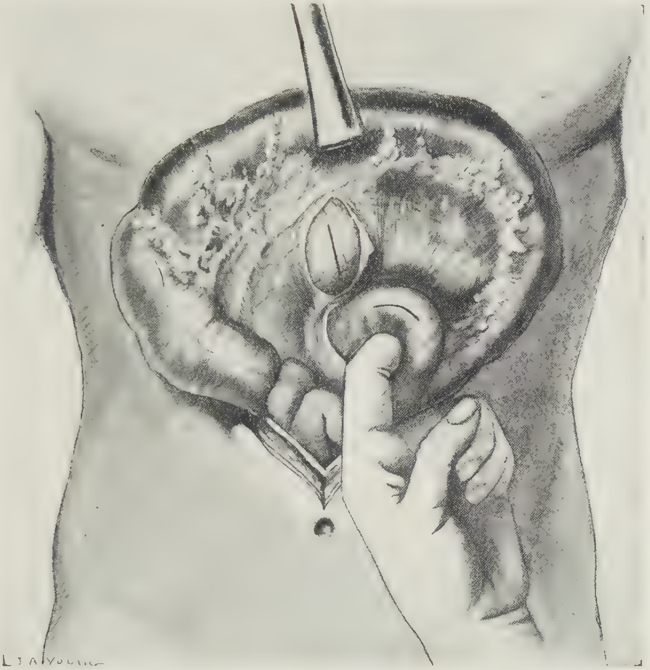


Fig. 3530.—Posterior, or Transmesocolic Gastrojejunostomy, by the No-loop Method – I; – Locating the beginning of the jejunum – after drawing the transverse colon and mesocolon out of the abdomen and displacing them upward. The finger is hooked around the jejunum just distal to the duodenojejunal junction. The mesocolon has been incised preparatorily to drawing the posterior wall of the stomach through the mesocolic opening. The viscera will be incised and anastomosed along the lines marked.

At the site where, normally, a fold of peritoneum connects the inferior aspect of the mesocolon to the first 2.2 cm. (1 inch) of the jejunum, the mesocolon is caught with forceps and drawn away from the posterior stomach wall, while its structure is divided by knife or scissors, through a non-vascular area, just to the left of the duodenojejunal junction – thus opening up the lesser peritoneal sac, through a vertical aperture of about 7.6 cm. (3 inches) in length. Any vessel divided in this incision is ligated.

Next in order is the planning of the sites and directions of the openings in the stomach and jejunum – and the clamping and bringing of these structures into relationship for incision and anastomosis. Surgeons differ somewhat in the exact position and direction of the anastomosing incisions, and in the manner of clamping the viscera. The technic which is probably the most generally adopted will be given. The incision into the stomach should be vertical, extending from the direction of the lesser curvature and ending at the greater curvature _ and be placed as near the pyloric end of the stomach as the con-

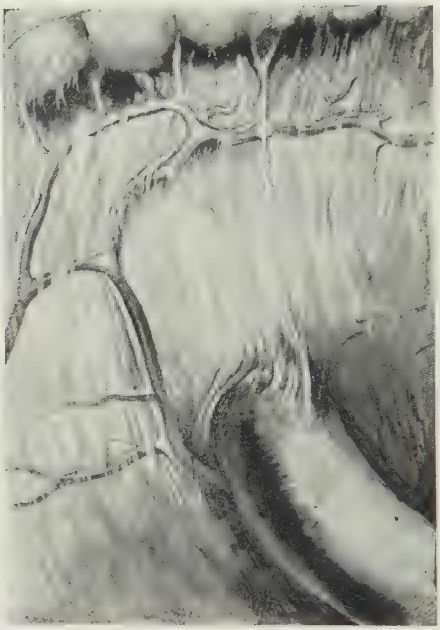
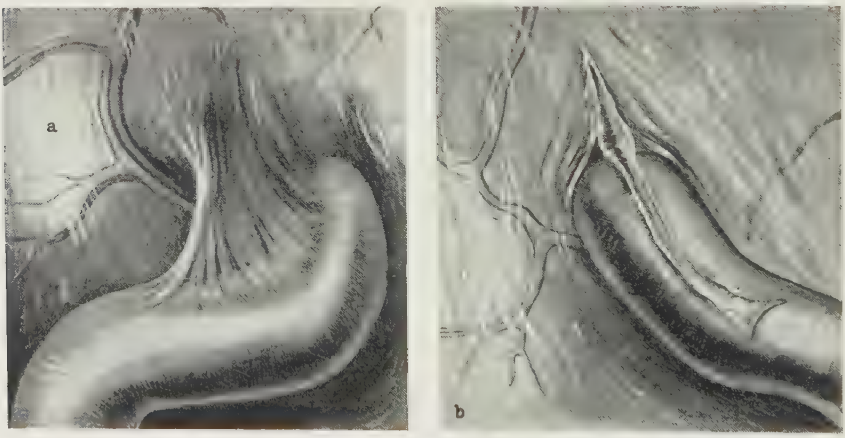


Fig. 3531.—The Duodenojejunal Junction _ showing a normal ligament of Treitz, with normal trend of the jejunum to the left. (Figs. 3531–3533 modified from the Mayos.)



Figs. 3532 and 3533.—The Same, _ I: _ a, Ligament of Treitz with an extensive fold of peritoneum exercising a determining influence upon the direction of the adjacent portion of the jejunum _ turning it to the patient's right; _ b, division of this ligament _ so that this portion of the jejunum swings back to the patient's left, in direction.

ditions permit. The incision into the jejunum begins as near the duodenojejunal junction as possible _ so that the technic will constitute a "no-loop" operation. (The next best planning would be a very "short-loop" operation. Formerly, a considerable loop was often made.) Some Surgeons grasp the stomach with one double-bladed clamp and the jejunum with another double-bladed clamp. Others grasp stomach and jejunum within a single three-bladed clamp _ while, in the absence of all clamps, the viscera may be held in relationship with tenaculum-forceps, traction loops, or even the fingers _ these last methods being described under Comments. The different positions of the clamps will be mentioned in the course of the description.

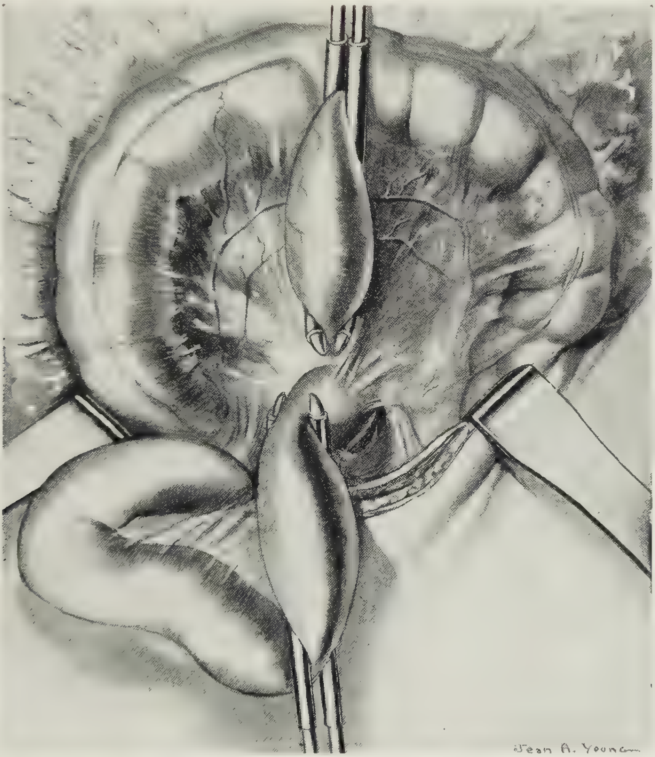


Fig. 3534.—The Same, _ II; _ The posterior stomach wall has been drawn through the slit mesocolon and clamped in a vertical fold. The beginning of the jejunum has been clamped in an axial fold, upon its antimesenteric aspect. The clamps and visceral folds form, practically, a straight vertical line.

To bring the posterior wall of the stomach into the field, the Surgeon carries the flatly outstretched fingers of his left hand over the transverse colon and omentum, into the greater peritoneal cavity, until the pulps of his fingers are against the anterior wall of the stomach, when, by flexing his fingers, he protrudes the posterior wall of the stomach through the lesser peritoneal cavity and out into the greater peritoneal cavity, through the artificially made opening in the transverse mesocolon, between the middle and left colonic arteries. Upon its appearance at this opening, the Surgeon seizes the protruding posterior wall with his right hand, and draws as much of it through as will be needed to clamp off the vertical fold used in the anastomosis. The posterior stomach wall is then grasped with a double-bladed clamp so as to form a vertical fold of sufficient width, and extending from lesser to greater curvature, at about the junction of the vertical and horizontal portions of the upper border of the stomach _ the clamp being so applied that its handle is toward the greater curvature (toward the patient's head, in the everted position of the parts), and the tip toward the lesser curvature (Fig. 3534). The omentum, transverse colon, and clamped stomach are now temporarily returned to the abdominal cavity through the upper part of the wound _ and protected and held out of the way by gauze pads.

The proximal, or highest part of the jejunum, is now put under moderate tension by drawing upon it from the duodenojejunal junction _ and, while so held, is seized, in its antimesenteric axis, in such a way as to form a sufficiently broad fold for anastomosis with the stomach _ the clamped fold of jejunum extending as near as possible to the duodenojejunal junction, with which the tip of the clamp should be in contact, while the handle of the clamp points toward the patient's feet _ as shown in the last illustration. To enable the jejunum to be satisfactorily clamped up to the duodenojejunal junction, any existing adhesions should be cut, as well as an unnatural prolongation of the ligament of Treitz, as already explained.

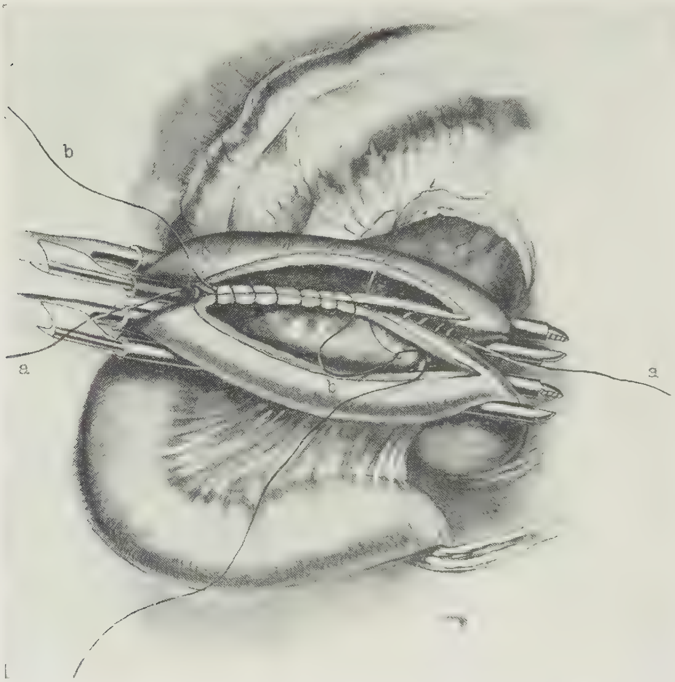


Fig. 3535.—The Same, _ III: _ The clamped pouches of stomach and jejunum are approximated _ ready for anastomosis. This is accomplished by first lowering the stomach clamp and elevating the jejunal clamp in a vertical line _ after which the clamps are brought toward the patient's right, and each clamp is then turned through a quarter circle away from each other _ thus bringing the clamped loops into convenient relationship for suturing. The posterior seromuscular suture has been placed, **a, a,** _ and the posterior marginal suture, **b, b,** is being placed, after having incised each clamped loop axially.

Up to this point the clamps, with their clamped viscera, have lain in a more or less median line. They are now brought together, to one side or the other (generally the patient's right) _ by lowering the stomach-clamp and elevating the jejunal clamp, until the instruments lie parallel, from handles to tips – with the clamped fold of stomach in direct contact with the clamped fold of jejunum (Fig. 3535). About 7.7 cm. (3 inches) of a vertical fold of the anterior stomach wall is included in the gastric clamp – and a corresponding length of axial fold of the antimesenteric aspect of the jejunum, in the jejunal clamp. The clamps and parallel folds of viscera are delivered outside of the abdomen, and are carefully packed off with gauze from the rest of the field. This packing of the field against soiling by leakage during operation is important – and may be reinforced by cigarette-rolls of gauze placed between both ends and handles of each set of clamps or between the mid and adjacent blade of the triple clamp. To accomplish this degree of delivery, the omentum and transverse colon must also, of course, be again brought outside of the abdomen. When all is in readiness for the immediate steps of anastomosis, the disposition of the clamped and neighboring parts is as shown in the illustration last quoted, where the gauze packing is omitted for the sake of clearness.

The anastomosis is accomplished by the combination of the continuous Lembert suture of the serosa and muscularis, to approximate the outlying surfaces surrounding the site of union – and by the continuous Albert suture of the margins (see the Lembert-Albert Suture, p. 247). The posterior margins of the mucosa are sometimes sutured separately. In clamping the loops of stomach and jejunum, preparatorily to suturing, care should be taken not to clamp them crushingly enough to destroy their vitality at and beyond the lines of clamping. The suture material is usually fine Pagenstecher linen or silk – threaded upon a curved intestinal needle, carried in a needle-holder. A straight needle, hand-held, may be also used, except for the first tier posteriorly. The parts which are being sutured are steadied with forceps, during the passage of the needle. The details of suturing are the same as in the anterior operation. Beginning at the more convenient end, usually the left, a line of continuous suturing passes through the serous and muscular coats of the loops of stomach and intestine, where they lie in contact between the two pairs of clamps as the posterior layer of the outer tier of suturing – knotting the first stitch, with a long free end left, and leaving the needle threaded when the tier is run to the opposite end. This is carried along what will form the posterior line of union, the stitches being inserted at rather close intervals (8 or 10 to the 2.5 cm., or inch), forming one-half of a shallow ellipse in their course, and extending about 1.2 cm. (½ inch) beyond the limits of the incisions at each end – as shown in Fig. 3535. The suture line should be about 10 cm. (2½ inches) long.

The serosa and muscularis of the gastric and intestinal folds are now incised along a line about 6 mm. (¼ inch) from the suture line, and to within 1.2 cm. (½ inch) of its end. As soon as these incisions are made, the lax mucosa of both stomach and intestine tend to bulge through the incised serosa and musculares, in the form of a narrow ellipse. This bulging mucosa of stomach and jejunum is seized at one end with forceps and first incised with scissors, and then excised up to near the cut edges of the two outer coats. Just prior to incising the mucosa one must make provision for catching any fluid which may escape from stomach or intestine, which will occur to some extent in spite of the effort previously made to press all contents outside of the folds about to be clamped. Serosa, muscularis, and mucosa are often incised together. All is now ready for the posterior layer of the inner marginal suture of all the coats of the stomach opening to the corresponding coats of the jejunal opening. By this continuous suture the edges of the openings are approximated, and, at the same time, bleeding from these edges is controlled. This line of suturing is begun at the more convenient end, usually the left end of the viscera – entering the mucosa of one viscus from which it passes, outward, to its serosa, thence to pass from serosa to mucosa of the opposite viscus, after which it is knotted upon the mucosal aspect — a long end of the suture being left. A running, overhand continuous suture of the posterior margins is thus accomplished, drawing each stitch somewhat tautly as it is made (Fig. 3536). The posterior layer of the marginal suture having been completed, the anterior layer of this suture is placed. The needled end of this tier is taken up and continued around the anterior margins of the opening, in precisely the same manner as around the posterior margins — with this difference, that while the stitch unit in traversing the posterior margins was from within outward (from mucosa to serosa and serosa to mucosa), the stitch unit in traversing the anterior margins is from without inward (from serosa to mucosa and mucosa to serosa). Each stitch is here also tightened as made. As the suture terminates within, the ends are knotted on the outside, and the knot pushed within. The common opening between stomach and jejunum is thus everywhere closed along its margin. After the lumina of the viscera are closed, hands are washed and gowns and instruments are changed. Finally, the anterior layer of the outer or seromuscular suture is placed — by carrying the continuous Lembert suture, left threaded after the completion of its posterior tour, along the outlying anterior aspect of the anastomosis — to be knotted with its free end left for that purpose (Fig. 3537). The outer seromuscular line of surface suturing inverts the inner marginal line of through-and-through

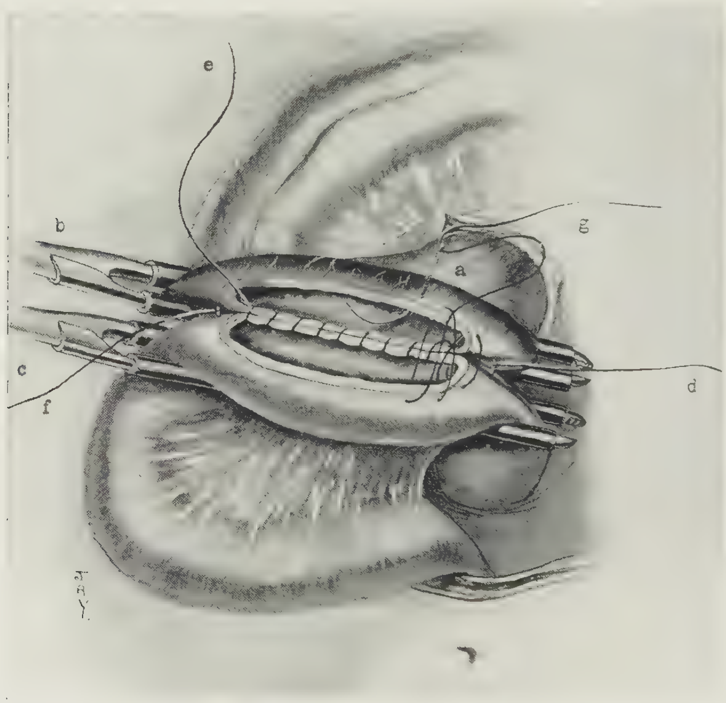


Fig. 3536.—The Same, — IV: — **a,** Stomach brought through the incised transverse mesocolon; — **b,** clamped portion of stomach; — **c,** clamped loop of jejunum; — **d, f,** posterior seromuscular suture — its terminal end left long, ready to be continued anteriorly; — **e,** beginning of posterior marginal suture; — **g,** the present position of the anterior marginal suture, or anterior continuation of the posterior marginal suture.

suturing – and placing of the last marginal knot within the cavities leaves no outward drain for infection of the suture line.

The clamps are now withdrawn, and preparation made for anchoring the margins of the artificial opening made in the mesocolon. Suturing of the margins of the mesocolic slit to the posterior stomach wall, within 1.2 to 2.5 cm. ($\frac{1}{2}$–1 inch) from the anastomosis, was originally systematically carried out – and then, because considered unnecessary, sometimes omitted. But through this omission, the small intestine has been found herniated into the lesser peritoneal cavity. The mesocolic margins have also been sutured to the jejunum, near the anastomosis – but this technic has sometimes caused obstruction. The Mayos have satisfactorily "turned the margins of the opening underneath and sutured the peritoneum of the lower surface, with three or four stitches, to the suture line which unites stomach and jejunum." In two cases, however, in which they did this, where the transverse mesocolon was quite fatty, the mesocolon so sutured, formed a collar-like mass around the stoma and had to be liberated by operation. Their conclusions, therefore, are that the margins of the opening in non-fatty transverse mesocolons should be sutured to the gastrojejunal suture line by several sutures, neatly tucking the edges of the opening underneath, that there will be no raw surfaces left in the field to form adhesions – but that in fatty mesocolons, the margins of the opening should be sutured, as of old, to the posterior stomach wall, about 1.9 cm. ($\frac{3}{4}$ inch) from the line of anastomosis. Burghard accomplishes the

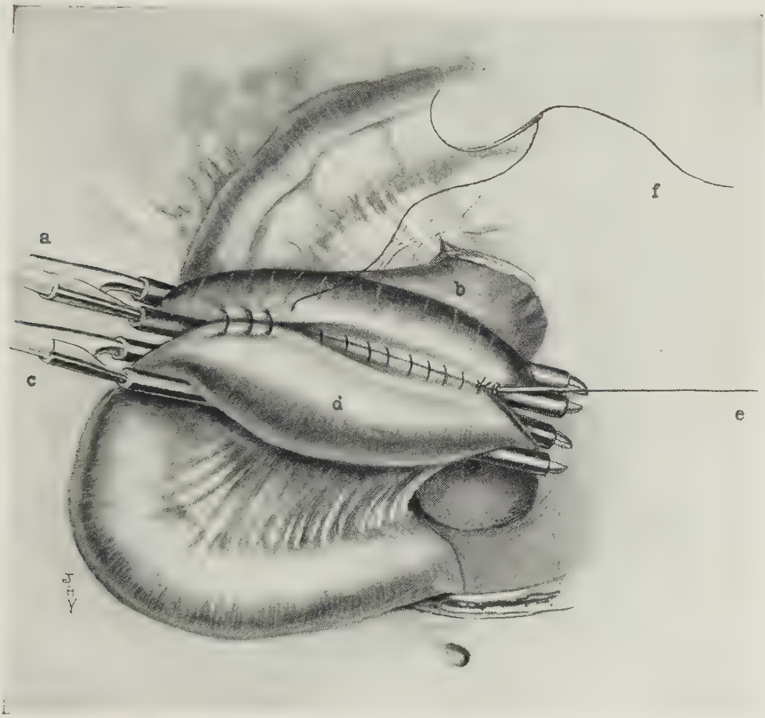


Fig. 3537.—The Same, – V: – **b**, The free portion of the stomach; – **a**, clamped portion of the stomach; – **c, d,** clamped loop of the jejunum; – **e,** posterior seromuscular portion of the suture; – **f,** anterior portion of the seromuscular suture – which will be eventually tied with e.

same general technic by drawing the transverse colon and omentum out from the upper part of the abdominal wound and tensing the transverse colon by lifting it away from the abdominal wall – and, while the edge of the mesocolic opening is held with forceps, the mesocolon is picked up by stitches placed at some distance from the edge of the opening – the needle then being passed through the outer coats of stomach and jejunum, at the common suture line, or through the jejunum alone, as close as possible to the suture line – the stitch, when tightened, rolling the free edge of the mesocolon inward toward the lesser peritoneal sac. Several such sutures are passed, similarly approximating the rest of the mesocolon around the site of anastomosis. In this way the lesser peritoneal cavity is shut off, and the rough edges of the mesocolic opening are so turned inward that only smooth peritoneum is folded over the suture line and is unlikely to form adhesions. Bier states that it is absolutely important to anchor the split margins of the mesocolon – but that it does not, in his judgment, make any difference whether the anchorage be to the stomach, or to the jejunum, just so it be secure. The anchorage of the non-fatty mesocolic margins to the anastomotic suture line is shown in Fig. 3538, which also shows the completed operation, with the parts in the positions they occupy

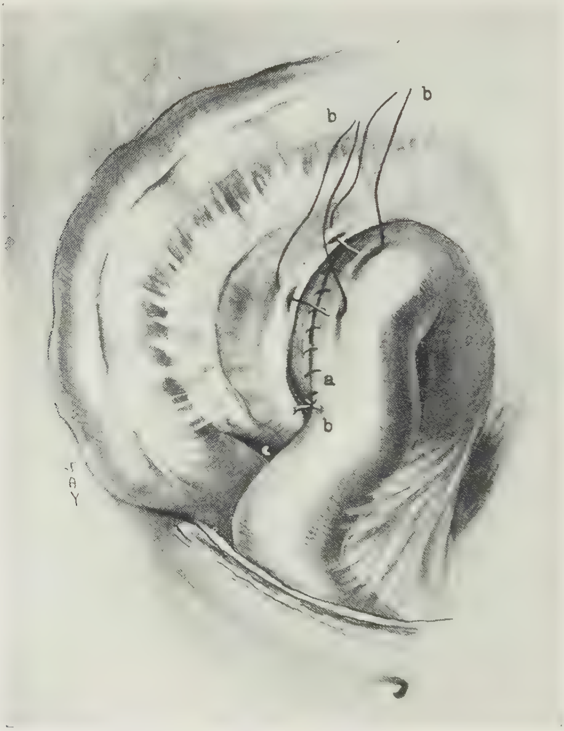


Fig. 3538.—The Same, – VI; – Anchorage of the split margins of the non-fatty mesocolon to the gastrojejunal suture line – the mesocolon being picked up by a stitch at such a distance from its raw margin as to admit of the turning in of its free edge into the lesser peritoneal cavity – thereby leaving only a smooth surface in the region of the anastomosis (instead of a raw edge). The suturing of the right side is here shown. The suturing of the left side is similarly accomplished by displacing the jejunum to the opposite side. The position of the parts in the completed operation is here shown, before the transverse colon and mesocolon are turned forward and downward into place.

before the transverse colon and mesocolon are turned forward and downward into their normal positions.

The displaced viscera are now carefully replaced within the abdomen and returned to their normal sites _ with especial precaution that the portion of the jejunum immediately distal to the anastomosis runs in the correct direction (Fig. 3539). The abdomen is closed as after the usual paramedian abdominal section.

Comments.—In opening the abdomen by the paramedian method, instead of displacing the rectus outward, after opening the sheath, it is sometimes split _ though the former procedure is preferable, as the abdominal wall is left stronger.

In splitting the mesocolon, it may not be as easy to demonstrate the lesser peritoneal cavity as anticipated _ due either to adhesions between the mesocolon and posterior stomach wall, or to the fact that the layers of the mesocolon have been simply separated rather than completely incised.

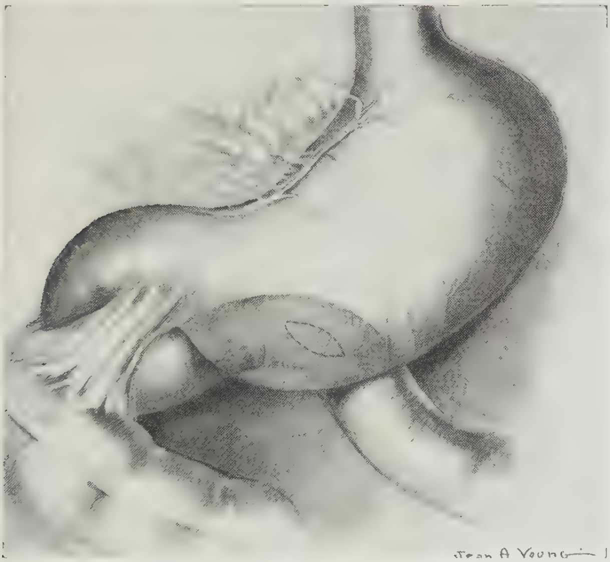


Fig. 3539.—The Same, _ VII; _ The position of the anastomosed parts, at the completion of the operation, when they are about to be turned back into their normal positions within the abdomen _ in the no-loop, antiperistaltic posterior gastrojejunostomy operation.

If in any step of the operation a divided vessel is encountered, it should be ligatured with fine catgut.

In using a triple clamp the gastric fold is drawn between the middle and upper blades, while the tips of the blades are pointing toward the patient's head, and the handles toward his feet _ after which the handles are elevated to the patient's left, and the intestinal fold drawn through between the middle and lower blades _ as shown in Fig. 3540. The suturing is carried on with the clamps in this position.

Burghard uses a special type of intestinal needle, with slot-eye, very slightly thicker than the finest Pagenstecher when doubled, the suture thus occupying practically all of the needle puncture. By drawing the suture tautly after each needle puncture, hemostasis is secured, and the intestinal margins are prominently ridged-up ready for the next needle puncture.

While the inner suture line is spoken of as a marginal suture, it is really the very narrow strip of serosa of each lip between the edge and the needle puncture which comes into contact with a corresponding strip upon the opposite side, thus really inverting (and not approximating) the margins proper.

While both inner and outer suture lines are usually of silk or Pagenstecher, the inner is sometimes of chromic catgut.

Moynihan holds that there is, normally, no "natural direction" of the jejunum at its origin, but that it is free there to move in any direction, according to the position of the body _ and that the vertical position is the one most frequently occupied, and therefore the position best to maintain in posterior gastrojejunostomy. When unnatural adhesions, however, are present, the first part of the jejunum tends to be displaced to the right.

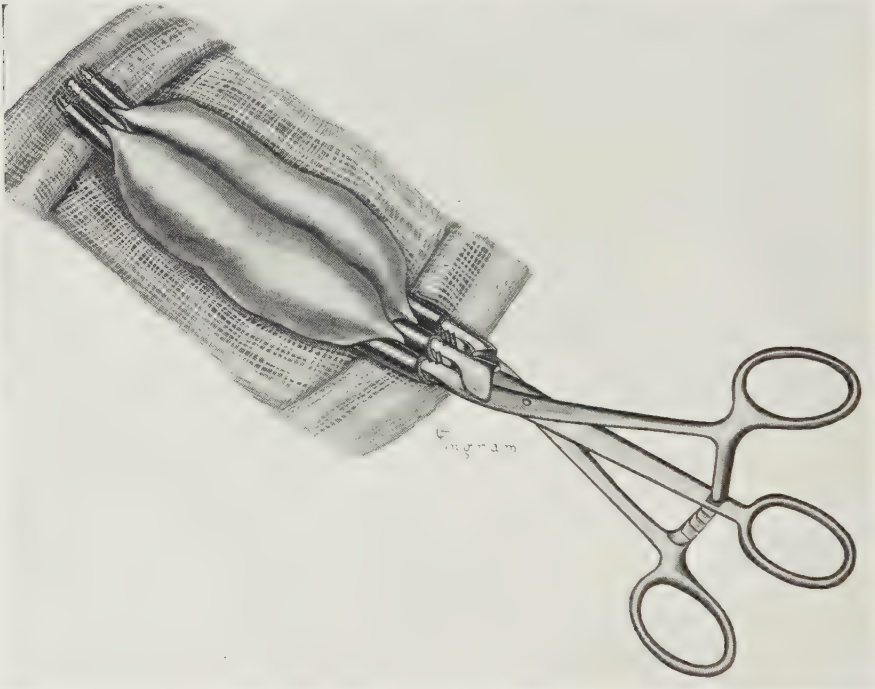


Fig. 3540.—Usage of Triple-bladed Clamps in the Lateral Anastomosis of the Stomach and Intestinal Tracts _ or of Parts of the Intestine to Each Other.

The clamp which holds the jejunum compresses its mesentery near the attachment of the intestine.

In incising the mucosa of either viscus, if any vessels are seen crossing what will be the line of incision, are first under-run and ligated.

The anastomotic opening is generally from 5 to 7.5 cm. (2 to 3 inches) in length.

It is well to occasionally have an Assistant cleanse the suture line with a gauze mop dipped into warm normal saline solution.

As an added precaution, some Surgeons anchor the left aspect of the jejunal loop to the stomach wall by one or two additional seromuscular sutures, placed above and to the left of the anastomosis.

The Mayos sometimes employ a third line of suturing _ of the cut margins of the mucosa along the posterior aspect of the anastomosis — the method of its application being the same as already described in anterior gastrojejunostomy (p. 306).

In placing the two anterior and two posterior lines of continuous suturing, it would seem well to knot them upon themselves at intervals, without interrupting their continuity — to prevent the suture from acting as a draw-string — although Moynihan advises against this.

The operation as above described may be described as an antiperistaltic anastomosis (as shown in Fig. 3528, A) — and is the technic worked out by the Mayos — and the one generally employed in America. It is based upon the assumption that the first part of the jejunum naturally turns downward and to the left — and that the turning of the jejunum to the right, in performing posterior gastrojejunostomy, tends to produce a twisting of the jejunum above the anastomosis, and, therefore, really increases the dangers ascribed to "vicious circle." Moynihan, with his experience in gastric surgery, and a large number of gastro-enterostomies to his credit, still endorses the technic of isoperistaltic anastomosis (Fig. 3529, B), which he accomplishes by turning the jejunum to the right, in making the anastomosis — denying that twisting and vicious circle are thereby made more likely to occur.

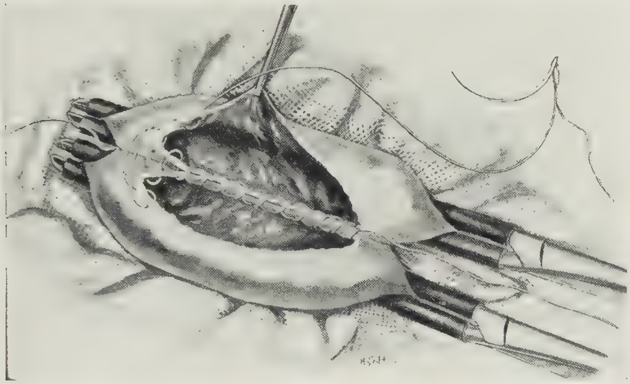


Fig. 3541.—"The Loop on the Mucosa" Method of Reversing the Anterior Marginal Anastomotic Suture; — In order to puncture the anterior margins from the serosa of one to the serosa of the other (instead of puncturing from the mucosa of one to the mucosa of the other, as on the posterior margins) the suture, in making the turn into the anterior margins, passes from the mucosa of one viscus to the serosa of the same viscus — then from the serosa to the mucosa of the opposite viscus — and from the mucosa to the serosa of the same viscus — thus leaving a "loop upon the mucosa" — before passing over to the opposite viscus. This stitch may be continued on to the end, or it may simply serve as the beginning of a marginal "whipping-over" stitch (from the serosa of one viscus to the serosa of the opposite viscus). The feature of the stitch is, that each unit of its make-up passes twice through the margin of one viscus before passing to the margin of the opposite viscus, where the technic is repeated. Moynihan writes: "This is the prettiest stitch in all surgery; to see the inversion of the two edges occurring as each turn of the suture is tightened is quite pleasing." The final knot is within the lumen.

The suturing may be conveniently carried out exactly as described in the body of the article. It is, however, often modified by Surgeons in various ways. The chief difficulties experienced usually occur when the posterior layer of the marginal suture turns forward to form the anterior layer, at one of the ends of the opening. Some Surgeons here resort to what is termed the "loop on the mucosa" method (Fig. 3541). This is simply a method of reversing the suture — and enables the stitch, from mucosa to serosa, to reverse itself and pass from serosa to mucosa. It can be utilized in two ways, — either as a single loop on the mucosa to start the continuous suture upon the reverse (in which case the preceding and following punctures must be closer than usual and the distance on the opposite side evenly parcelled out), – or these "loops on the mucosa" may be continued on to the end of the anterior layer, as Moynihan suggests, constituting the "pillow-maker's stitch.")

The Mayos apply three rows of sutures to the posterior aspect of the the anastomosis (the third row uniting the edges of the mucosa), to control possible bleeding – the incision of the viscera and placing of the sutures being done in the same manner as described in the anterior operation (p. 306).

Some Surgeons prefer to perform gastrojejunostomy without the intervention of clamps, in order to lessen the chance of postoperative hemorrhage. This technic will be described in the following operation.

The Mayos suggest that jejunal ulcers (which may occur either from infarcts, or from retained permanent suture material, and probably from acid gastric juice, where alkaline reaction is physiologic), may be lessened in frequency by the adoption of two rows of chromic catgut, protected by interrupted silk sutures – or one row of chromic catgut, with interrupted silk sutures for the second row.

Complications and Cause of Failure Following Gastrojejunostomy.—Hemorrhage; – regurgitant vomiting; – jejunal ulcer; – intestinal obstruction including internal hernia; – diarrhea; too rapid stomach emptying; – gradual closing of the anastomotic opening; – gastric ulcer.

Absorbable suture should always be used in the through-and-through stitch of all gastro-enterostomies, owing to the frequent finding of non-absorbable suture material in contact with ulcers.

POSTERIOR GASTROJEJUNOSTOMY BY THE LOOP METHOD, ACCOMPLISHED BY SIMPLE SUTURING OR BY THE MURPHY BUTTON (WITH OR WITHOUT THE USE OF CLAMPS)

Description.—It is to be understood that the operation last described is the one of choice – in all of those cases in which it is applicable. Under the above heading will be described a technic sometimes employed as an alternate measure in those cases where, for one reason or another, the posterior no-loop operation is not feasible, and where some length of jejunal loop must be employed, as was formerly the routine, and may be even now sometimes necessitated. Both the gastrojejunostomy and the jejunojejunostomy may be performed by simple suturing – or by the Murphy button, – or the gastrojejunostomy may be accomplished by simple suturing, and the jejunojejunostomy by the Murphy button, – or vice versa. The anastomoses are more conveniently and technically accomplished through the aid of clamps (as described in the anterior and posterior operations just given) – but, for the sake of illustration, will be here performed without approximation clamps. All loop-operations, anterior or posterior, should be followed by at least a single jejunojejunostomy, and sometimes by a double jejunojejunostomy. The need for making the gastrojejunostomy isoperistaltic is not as pressing as it is when no jejunojejunostomy is to follow the main operation.

Preparation – Position – Landmarks – Incision.—As in the operation of posterior gastrojejunostomy by the no-loop method, just described.

Operation.—The parts are exposed by the right paramedian abdominal section – and all of the steps of the operation are precisely the same as those last described – up to the exposure of the posterior wall of the stomach through a slit in the mesocolon, and the beginning of the jejunum, together with the first loop distal to the duodenojejunal angle – with the proper delivery of these for manipulation, and the packing off of the surrounding structures with gauze pads. Henceforth only those steps of the operation will be considered which materially differ from the ones already described.

Where gastro-enterostomy clamps are employed, they are adjusted in the same general way, as to principle, as in the posterior no-loop operation (to both stomach and jejunum) — except that their manipulation is easier, owing to greater extent of jejunum to deal with.

Where no technical clamps are available, the aspects of posterior stomach wall and jejunum may be held in apposition by being grasped at either end of the included regions by some convenient form of shallow-toothed, lightly closing (non-traumatizing) forceps — as shown in Fig. 3542. The parallel antimesenteric aspects of the jejunum may be similarly approximated. It is here even more important to thoroughly protect the surrounding regions than when using occluding clamps, and especially posteriorly to the site of anastomosis, from soiling by leakage, before incising the parts.

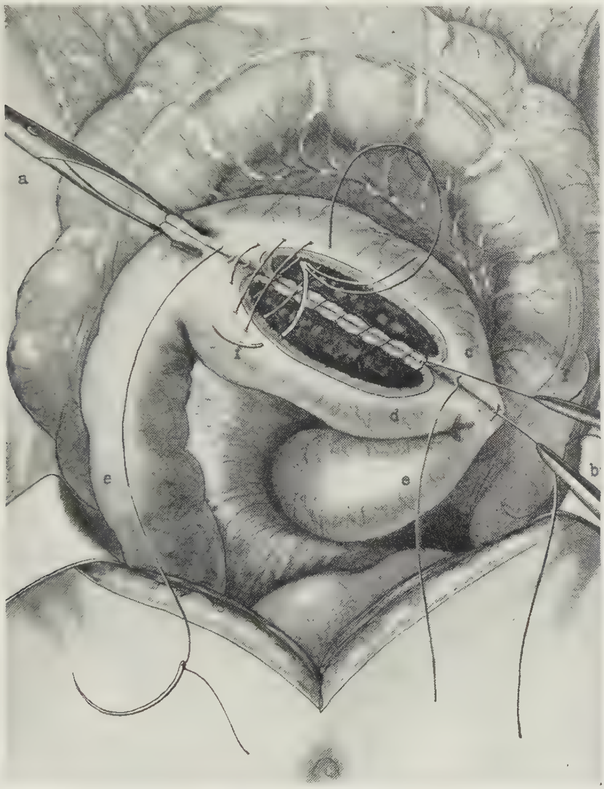


Fig. 3542.—Posterior Gastrojejunostomy, Without Clamps, and by Simple Suturing; — Parallel folds of the posterior stomach wall, **c**, and of the jejunal loop, **d**, have been approximated, and are being held in relationship by non-traumatizing intestinal forceps, **a**, at one end — and by a non-penetrating traction-suture, **b**, at the other. The posterior stomach wall has been drawn through the incised mesocolon. The limbs of the duodenum proximal and distal to the anastomosis are seen to either side. **e, e,** The posterior seromuscular suture. The posterior marginal suture has been begun at **c** — and has rounded into the anterior marginal suture at **f**.

Where the anastomosis is made by simple suturing, the viscera are incised and sutured in precisely the same manner as in the posterior no-loop operation just described — in both the gastrojejunostomy and in the jejunojejunostomy.

Where the anastomosis of stomach to jejunum, and of jejunum to jejunum is made by the Murphy buttons, the large, special oval button is employed for the gastrojejunostomy, and the round button for the jejunojejunostomy. Their general method of introduction is the same as in side-to-side intestinal anastomosis by means of the button. The oval feature of the gastrojejunal button involves no different technic in its anchorage in the gastric or jejunal opening. The male half of the button is inserted into a convenient, relatively non-vascular part of the anterior wall of the stomach, nearer the greater curvature and the pyloric end, the ends of the button pointing directly or obliquely toward the curvatures of the stomach. The female half of the button is then inserted into the antimesenteric aspect of the jejunal loop _ both insertions of the half-buttons being conducted as in lateral entero-enterostomy by the Murphy button. The two half-buttons are shown ready for approximation in Fig. 3543. If considered necessary, the button anastomosis may be reinforced by two or three interrupted Lemberts.

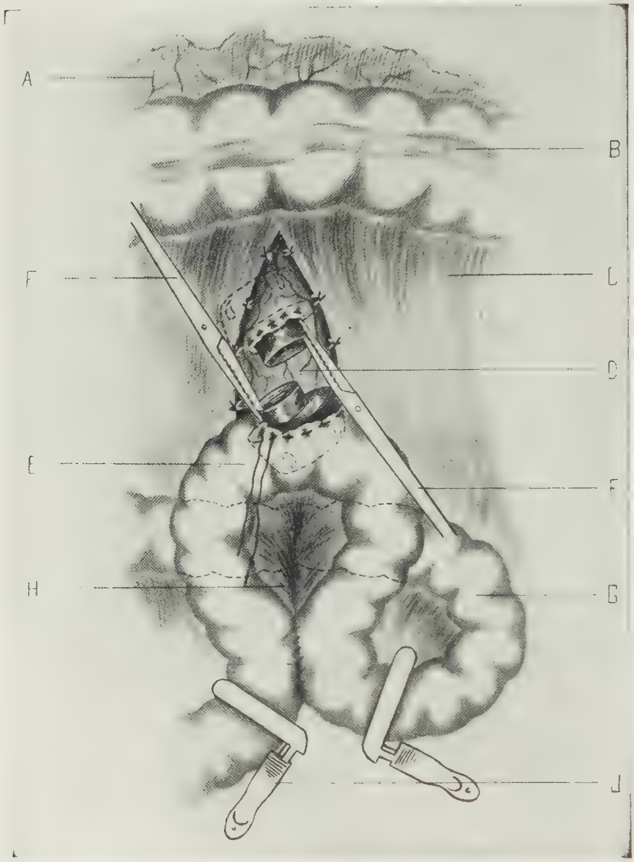


Fig. 3543.—Posterior Gastro-enterostomy by the Murphy Button, Followed by Entero-enterostomy: _ A and B, Great omentum and transverse colon turned upward; C, transverse mesocolon with edges of its incised wall sutured to posterior stomach wall; D, posterior stomach wall with a half-button inserted; E, coil of jejunum with a half-button inserted; F, F, forceps holding buttons; G, coil of jejunum, just beyond ligament of Treitz, given a half-turn; H, mesentery of jejunum; I, entero-enterostomy by simple suturing; J, intestinal clamps.

The button anastomosis of the antimesenteric aspect of the limbs of the jejunum, several inches below the stomach, is now accomplished in one of the following ways: _ (*a*) Button Anastomosis by the Common Method: _ The technic here employed is the usual side-to-side intestinal button anastomosis pictured on p. 326. (*b*) By Gallet's Method of Introducing Weir's Modification of the Murphy Button (Fig. 3526): _ When the incision is made into the loop of jejunum to be anastomosed to the posterior stomach wall, and before the female half of the gastrogastrostomy button is introduced into the jejunal loop, the male half of the special entero-enterostomy button, with the end of its cylinder beveled and sharpened, as modified by Weir, is introduced down the proximal limb of the jejunum, in the grasp of a pair of forceps, the handles of the forceps being steadied by an Assistant, _ and the female button, similarly grasped, is introduced down the distal limb of the jejunum _ and, while thus held, the two halves of the button are approximated and pressed home, the cutting cylinder of the male button cutting its way through the intervening wall of the proximal and distal limbs of the gut and finding its way into the female cylinder. No reinforcing suture is necessary, though a few Lemberts around the site of anastomosis make the technic safer. The forceps are now withdrawn from the limbs of the intestine through the opening in the jejunal loop or knuckle _ after which the female half of the gastro-enterostomy button is tied into the jejunal loop, and stomach and jejunum anastomosed by approximation of the button halves. (*c*) By Hartley's Method (Fig. 3527): _ The ordinary Murphy buttons are used _ the male button being dropped into the proximal limb, and the female button into the distal limb of the intestine, through the incised jejunal loop, prior to the tying-in of the male and female halves of the gastro-enterostomy button. The gastrojejunal anastomosis is then completed _ after which each button is grasped and, while so held as to bring their cylinders into contact with the antimesenteric aspect of the jejunum at the indicated site, two small incisions are made at right angles through the intestinal wall, which has been stretched, like a drum-head, over the ends of the cylinders _ the Surgeon steadying one button with the fingers of his left hand, and an Assistant steadying the other. The buttons are then pressed together in the usual fashion. It is wise to reinforce the site with a few Lemberts.

The anastomosed stomach-and-jejunum and the secondarily anastomosed jejunal-loops having been replaced, along with the transverse colon and mesocolon, the abdomen is closed as in right paramedian abdominal section.

Y-FORMED POSTERIOR GASTROJEJUNOSTOMY FOLLOWED BY JEJUNOJEJUNOSTOMY

ROUX'S OPERATION

Description.—Roux's Y-formed gastro-enterostomy consists, after the division of the jejunum, in a posterior end-in-side gastrojejunostomy, followed by an end-in-side jejunojejunostomy. It was devised to avoid the "vicious circle" which, in the former methods of gastro-enterostomy, were so apt to occur _ the object being to reproduce, as far as possible, the conditions present in the normal pyloroduodenal outlet. The method has proved serviceable in appropriate cases. It is a longer and somewhat more complicated operation than the usual methods of gastro-enterostomy. The hepatic and pancreatic secretions are thus admitted to the jejunum at a distance of about 7.5 cm. (3 inches) distal to the site of gastro-intestinal anastomosis, and are, therefore, less apt to enter the stomach and cause vomiting than in the more usual methods. The operation is diagrammatically shown in Fig. 3544.

Indications.—The chief indication for the Roux technic is in those cases where the posterior aspect of the stomach cannot be satisfactorily exposed because of adhesions, making the posterior no-loop gastrojejunostomy difficult or impossible.

Operation.—All of the steps of the operation are the same as those described in the posterior no-loop gastrojejunostomy _ up to the exposure of the posterior stomach wall and the jejunum. The jejunum is then transversely divided about 25 to 30.5 cm. (10–12 inches) distal to the duodenojejunal junction (Fig. 3544) _ the division taking place between two intestinal clamps placed about 25 and 30.5 cm. (10 and 12 inches) respectively, from the duodenojejunal flexure and extending far enough into the mesentery to allow the proximal and distal cut ends to be separated. The escaping intestinal contents are carefully caught, and the parts are cleansed with warm normal saline solution, upon gauze. The clamped end of the proximal portion of jejunum is temporarily wrapped in gauze and laid to one side. The new pyloric outlet is made by implanting the distal cut and clamped end of the jejunum into the clamped posterior wall of the stomach (which has been drawn through the split mesocolon), near to the greater curvature. The implantation is accomplished, after incising the stomach wall, in the same manner as is end-in-side intestinal anastomosis, or, indeed, as in the posterior end-in-side gastrojejunostomy (Fig. 3545). Roux employed three tiers of sutures. The margins of split mesocolon are sutured to the stomach wall.

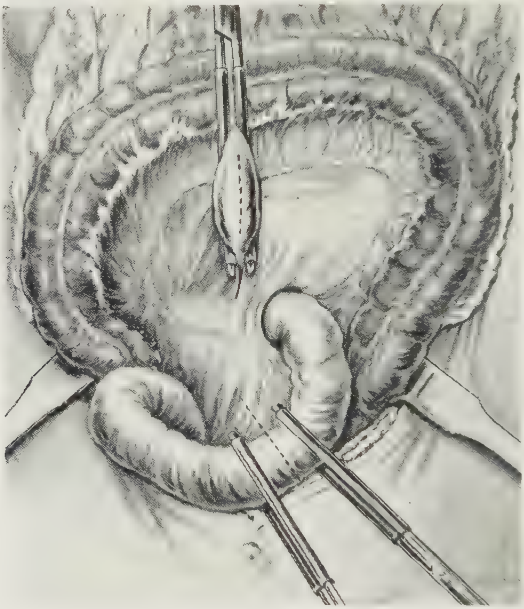


Fig. 3544.—Roux's Y-formed Posterior Gastrojejunostomy _ I; _ The posterior stomach wall has been exposed through the split transverse mesocolon _ and clamps have been placed upon the jejunum at about 25 and 30.5 cm. (10 and 12 inches) from the duodenojejunal flexure, preparatorily to transversely dividing the jejunum between them. Division into the mesentery has been extended a short distance for mobilization. The site of incision of the stomach is dotted.

The severed proximal end of the jejunum, which has been clamped and protected in gauze, is now anastomed, end in side, to the side of the distal limb of the jejunum, at about 7.5 cm. (3 inches) below the site of the gastrojejunostomy _ the technic being the same as described for end-in-side intestinal anastomosis (q. v.). The parts are returned and the abdomen closed.

Comments.—If the transversely divided distal end of the jejunum seem too small to furnish satisfactory emptying from the stomach, additional intestinal outlet is secured by beveling this distal end by obliquely cutting it before making the gastrojejunal anastomosis.

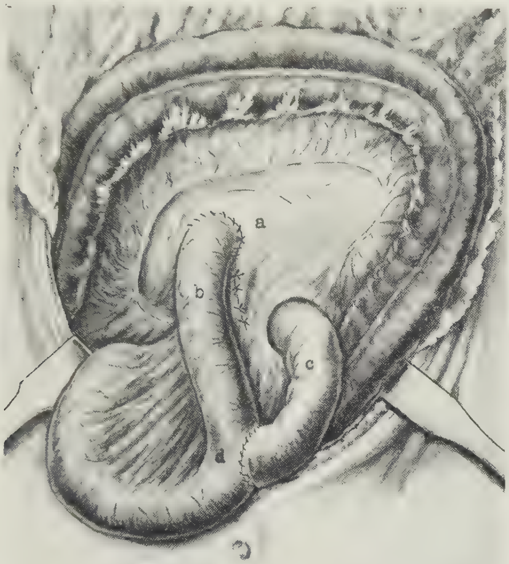


Fig. 3545.—The Same _ II; _ The end-in-side gastrojejunostomy of the posterior stomach wall and distal end of the jejunum has been completed _ as well as the end-in-side jejunojejunostomy between the end of the proximal jejunum and the side of the distal portion of jejunum. The split margins of the transverse mesocolon have been sutured to the posterior wall of the stomach.

If indicated, the jejunum can be drawn through the split gastrocolic omentum and anastomosed with the anterior stomach wall.

OPERATIVE TREATMENT OF GASTRIC AND OF DUODENAL ULCERS, IN GENERAL

Ulcers of the stomach and of the duodenum will be considered under a single heading owing to their proximity, similarity, and interrelation _ their consideration constituting, with cancer, one of the two most important chapters in the surgery of the stomach. Further, it is frequently impossible to determine, in advance, whether one be dealing with an ulcer of the stomach (especially of the pylorus) or of the duodenum _ and when the determination is made, the treatment is practically the same.

An idea of the importance of gastric and duodenal ulcers may be gleaned from that fact that it is calculated that about 80 per cent. of all operations upon the stomach and duodenum is done for ulcers alone.

The most reliable means of diagnosing gastric and duodenal ulcers is the *x*-ray. And the importance of the determination is the opportunity afforded for the removal of a lesion which is often followed by the crippling of the stomach, and so often the forerunner of cancer.

Gastric and duodenal ulcers may be acute or chronic _ the former have usually been regarded as a medical condition, and treated medically — unless the amount of bleeding from the site of an erosion, acute or chronic, calls for immediate operation for hemorrhage control. Perforation of a gastric or duodenal ulcer, if recognized, calls for immediate operation. Chronic ulcers are usually treated surgically. If ulcer of the stomach or duodenum be not cured by medical treatment, or recurs after medical treatment, it should be subjected to operation. There is no absolute consensus of view that ulcer sites tend to become cancerous — indeed, there is refutation of the view in some quarters — but the weight of surgical opinion is that such is frequently the case. Wilson and McCarty held that 71 per cent. of 153 tabulated cases of distinct gastric carcinoma showed, microscopically and macroscopically, evidences of previous ulcer.

The most serious consequences of acute ulceration are the occurrence of hemorrhage or of perforation, — and the most serious results of chronic ulceration are extensive adhesions, occulsion of the pylorus, hour-glass stomach, and cancer.

In a series of 1841 cases (of 437 females and 1384 males) of ulcers of the stomach and of the duodenum, acute and chronic, operated upon at the Mayo Clinics, up to December 31, 1913 (note this slight discrepancy, which must have been an error in the original statement), 636 were situated in the stomach and 1205 were in the duodenum — even though all of the early cases were supposed to be gastric, and were so classified. In the last 1000 cases, more accurately differentiated, 73.8 per cent. were duodenal — and 25.2 per cent. gastric. Of this last 1000 group, among the gastric ulcers, 29 per cent. were in females and 71 per cent. in males, — and among the duodenal ulcers, 21 per cent. were in females and 79 per cent in males. Differentiation between ulcers in the pylorus end of the stomach, and the first part of the duodenum, was determined, after exposure, for the purpose of classification, by the two constant and distinct veins situated exactly at the pylorus, coursing from behind forward, over the upper and lower borders of the duodenum, the pylorus being slightly notched where the veins turn forward — bounding the pylorus to the left and the duodenum to the right.

Gastric ulcers may be found in any part of the stomach — but their most frequent position is upon the lesser curvature, and more often upon its posterior than anterior aspect. They occur in the pyloric region of the stomach — but are least frequent upon the terminal 2 cm. ($\frac{3}{4}$ inch) of the pyloric end. They are also found upon both anterior and posterior walls of the stomach — Balfour stating that they are encountered upon the anterior wall in about 1 per cent. and upon the posterior wall in about 10 per cent. of the cases.

Duodenal ulcers generally occur within the first 5 cm. (2 inches) of the duodenum — and most frequently upon the anterosuperior wall. When situated upon the posterior wall they may be difficult to find because of being hidden by the projecting pyloric ring (Mayo).

According to Welch, the sites of relative frequency of gastric ulcers are as follows: — lesser curvature, 36 per cent., — posterior wall, 29 per cent., — pylorus, 12 per cent., — anterior wall, 8 per cent., — fundus, 3 per cent., — greater curvature, 3 per cent.

According to Brinton, 2 per cent. of the ulcers upon the posterior wall perforate, — 85 per cent. of those of the anterior wall, — 40 per cent. of those of the cardia, — and 10 per cent. of those of the pylorus.

Smithies, analyzing 1341 operations for gastric and duodenal ulcers in the Mayo Clinics, found 80 per cent. of the gastric ulcers in the pyloric half of the stomach and 40 per cent. at the pylorus.

In about 5 per cent. of cases multiple ulcers of stomach and duodenum are encountered – that is, separate ulcers of stomach and duodenum. Duodenal ulcers, in extending toward the stomach, usually stop short at the pylorus, but may undermine the pylorus. Duodenal ulcers may be encountered in the region of the papilla of the common duct – and usually cause profuse hemorrhage.

The stomach is more impaired by ulcer than the duodenum is – leaving the former more crippled in physiologic functioning than the latter.

The tendency of cancer to develop in the site of gastric ulcer does not seem to hold in the case of duodenal ulcer.

Extensive adhesions are apt to be encountered in dealing with ulcers of the stomach and duodenum – formed during localized peritonitis, as nature's protective barrier against perforation – and uniting the stomach or duodenum, or both, more or less inseparably with adjacent organs.

It has been found in operating in intervals following the acute manifestations of ulcer, and when it is supposed the ulcer is well, that the ulcer is often merely cicatrized but not healed.

Ulcers of the Lesser Curvature of the Stomach, furnishing the greatest number of gastric ulcers, also offer a large field for the wise selection of the appropriate operative method of dealing with the individual case. Simple gastrojejunostomy, which often suffices in other cases, is not so successful here. All in all, it is generally considered that excision of the ulcer, accompanied by the performance of posterior gastrojejunostomy, constitutes the most satisfactory routine technic in these cases. If the ulcer be of large size, partial gastrectomy is sometimes performed – either of the pyloric end of the stomach, followed by a gastroduodenostomy – or of the middle third of the stomach, followed by a gastrogastrostomy of the cardiac and pyloric ends.

Ulcers of the Posterior Wall of the Stomach are, naturally, difficult of access. If no adhesions exist, they may usually be reached by incising the gastrohepatic or gastrocolic omentum, or both. They may also be approached through an incision in the anterior wall of the stomach. The routine usually pursued in the case of a non-adherent ulcer of the posterior wall is to approach and excise it through the transgastric route. Moderate posterior adhesions can often be separated with a finger introduced either through the incised gastrohepatic or gastrocolic omentum. Excision is always preferable, but cannot always be accomplished. In large adherent ulcers of the posterior wall the stomach has been completely divided just to the cardiac side of the ulcer, and from lesser to greater curvature – after which the adhesions between stomach, on the one hand, and the pancreas, large vessels, and other important structures, upon the other, are separated (which can now be more readily and more safely done) – the ulcer is then excised – and the halves of the stomach sutured together with a double tier of sutures.

Ulcers of the Anterior Wall of the Stomach are usually the easiest of the gastroduodenal ulcers to remove. The gastric wall is steadied with forceps and the ulcer is elliptically excised. Unless there are adhesions of the anterior stomach wall to the abdominal wall, the procedure is usually simple. If the stomach be so distorted by the pathologic condition, or be so left by the operation, that it is difficult for it to empty itself into the duodenum, posterior gastrojejunostomy is also indicated in addition to the operation upon the ulcer.

Ulcers of the Pylorus and Duodenum often present very puzzling problems as to their treatment – William J. Mayo writes: – "In the large majority of cases gastro-enterostomy is the ideal operation for duodenal ulcer, with or without infolding the ulcer. In selected cases excision of the ulcer in conjunction with the gastroduodenostomy of Finney is the operation of choice." Formerly gastro-enterostomy alone was done in these cases, with no local treatment of the ulcer. Latterly local excision of the ulcer has been more frequently performed (especially in ulcers of the anterior duodenal wall, and without adhesions), accompanied by gastrojejunostomy. In some quarters, where excision and gastrojejunostomy was performed, pyloric exclusion (v. p. 351) was also practised. Pylorectomy is indicated in some extensive cases of ulcer – and in all cases of suspected malignancy.

Gastrojejunal Ulcers, though not strictly belonging in this chapter, may be conveniently mentioned here. Much uncertainty exists as to their exact nature and causation. They occur in about 3 per cent. of persons upon whom gastro-enterostomy has been performed. As some of the gastro-enterostomy thread has been found attached to the site of these postoperative cases, in a considerable number of instances, it has been concluded that some relation, probably causative, exists between the two. (For this possible connection only catgut is employed in the Mayo Clinics in the immediate suturing of the gastro-enterostomy openings.) Paterson, who has particularly investigated this subject, concludes that jejunal ulcers are the result of the altered physiologic conditions which follow gastro-enterostomy – and that gastrojejunal ulcers are probably a direct result of the operation. Their treatment will be mentioned at p. 354.

Attention is to be again called to the fact that one must not conclude because a single ulcer is found at operation that no others exist – but must prove that no others are present by thorough and systematic search. Abdomens have been opened some days after an original operation, to find a second ulcer which could and should have been operated upon at the original sitting.

The chief operations performed for ulcers of the stomach and of the duodenum are the following: –

(*a*) Operations for Hemorrhage from Ulcers of the Stomach and Duodenum: –

(1) Direct operation by excision, cauterization, vessel ligature, or mass ligature.

(2) Indirect operation by gastrojejunostomy.

(*b*) Operations for Perforation of Gastric and Duodenal Ulcers: – By suturing, and accompanying gastrojejunostomy, with or without accompanying pyloric occlusion.

(*c*) Operative Treatment of Perigastric Abscess from Perforating Ulcers of the Stomach and Duodenum: – Gastrolysis for Perigastric Adhesions (v. p. 250).

(*d*) Operations for Chronic Ulcers of the Stomach and Duodenum: – By simple posterior or anterior gastrojejunostomy; – Simple elliptic excision of a small ulcer of the lesser curvature, or of the anterior wall of the stomach; – Operation for ulcers of the lesser curvature and antrum of the stomach by actual cautery and accompanying gastrojejunostomy (Balfour); – Wedge-shaped excision of an ulcer of the lesser curvature, with or without accompanying gastrojejunostomy; – Transgastric excision of ulcers of the posterior wall of the body of the stomach (Mayo technic); – Operation for large ulcers of the body of the stomach by partial intercardiopyloric excision, followed by union of the cardiac and pyloric ends ("sleeve operation"), accompanied or not by gastro-enterostomy; – Operation for anteriorly placed, high-lying duodenal ulcer by infolding of the ulcer and by accompanying gastroduodenostomy (Balfour); – Operation for anteriorly placed duodenal ulcer by excision of the ulcer, with or without accompanying gastrojejunostomy; – Operation for posteriorly placed duodenal ulcer, either by combined excision and suturing, or by gastrojejunostomy; – Operation for pyloric ulcer by pylorectomy and accompanying gastro-enterostomy (Rodman).

(*e*) Pyloric Exclusion, employed together with gastrojejunostomy, in the treatment of Gastric and Duodenal Ulcers.

(*f*) Operative Treatment of Gastrojejunal Ulcers.

As numerous as the above operations are, they are only some of many technics — an excuse for which may be, in remembering that considerably more than 75 per cent. of all the operations performed upon the stomach and duodenum are, in some way, connected with ulcers of these parts.

It may be said, briefly, that the operations most frequently performed for gastric and duodenal ulcers are the following: — gastrojejunostomy; — gastrojejunostomy combined with excision of the ulcer; — gastrojejunostomy combined with inversion of the ulcer; — gastrojejunostomy combined with either excision of the ulcer and pyloric exclusion or with inversion of the ulcer and pyloric exclusion; — excision of the ulcer, with suturing; — excision of the ulcer-bearing part of the stomach, or duodenum, combined with gastro-enterostomy.

Balfour, in summarizing the results of 677 operations for the various forms of gastric ulcer, which had been operated upon in the Mayo Clinics in the 10 years ending with 1915, states: — "(1) For ulcers of the pylorus, posterior gastro-enterostomy is the operation of choice in those of poor surgical risk, for although pylorectomy is followed by better results, the operation mortality is distinctly higher. The cautery is a useful adjunct in selected cases. (2) For ulcers on the lesser curvature the cautery, by the method described in a previous paper (*i. e.*, the above-described method), is the operation of choice. (3) Local excision alone of such ulcers is inadequate, 32 per cent. of patients so operated upon ultimately requiring further operative treatment, namely, gastro-enterostomy. (4) Sleeve, or segmental resection, especially in large, high ulcers and hour-glass contraction, in suitable cases, is not only a relatively safe operation, but has been followed by good results. (5) The lowest operation mortality in the more common operations was associated with the cautery and posterior gastro-enterostomy. (6) Ulcers on the posterior wall are associated with the highest operation risk, while those at the pylorus are the least risk."

OPERATIVE TREATMENT OF HEMORRHAGE FROM ULCERS OF THE STOMACH AND DUODENUM

Hemorrhage from gastric and duodenal ulcers occurs with about equal frequency, and is accompanied with about the same degree of danger. But while hemorrhage from the duodenum nearly always comes from an ulcer, a considerable proportion of stomach hemorrhages may come from other causes than ulcer.

Brinton states: — "90 to 96 per cent. of gastric and duodenal hemorrhages cease spontaneously. Fatal hemorrhages occur in 4 to 10 per cent., and in 55 per cent. of these the splenic vessel is involved."

Savariand states: — "18½ per cent. of those dying from hemorrhage die so quickly that an operation could not be performed."

Mayo Robson states: — "Hemorrhages occur in a greater or less degree in from 50 to 80 per cent. of all cases of gastric ulcer, and, according to various authors, is fatal in from 3 to 11 per cent."

Rodman reports 10 operated cases, with 1 death.

Indications for Surgical Treatment of Hemorrhage from Gastric Ulcer.—Mayo Robson's conclusions are as follows: —

"(1) In a case of acute hematemesis from ulcer or erosion, when the onset of bleeding is sudden and the previous history of ulcer is absent, medical and general means should be very thoroughly tried. If the bleeding ceases as the result of rest and general treatment there will be no cause to interfere surgically, though the treatment should be carried out thoroughly and persistently until the ulcer has healed.

"(2) In case of recurrence of bleeding, or should the bleeding persist despite treatment, surgical measures are called for.

"(3) In case of bleeding from a chronic ulcer, whether the bleeding be slight or severe, surgical treatment is demanded, not only for the arrest of hemorrhage but also for the curative treatment of the ulcer itself.

"(4) As the risk during the quiescent interval is less than if the operation is undertaken while the bleeding is continuing, it is desirable, if possible, to secure arrest of the hemorrhage even in chronic ulcer before undertaking operation; but if the hemorrhage is persisting, the Surgeon is not justified in waiting until the patient is reduced to such a condition that it is too late to operate."

Briefly, operation is indicated when the hemorrhage is either so profuse or so continuous as to endanger the patient. Transfusion, or saline infusion, may be indicated before undertaking operation, or simultaneously with it.

Operation.—Two methods of treatment of hemorrhage from gastric ulcer are available, _ the Direct Method _ and the Indirect Method _ practised either independently or together.

The Direct Method includes such measures as excision of the ulcer, cauterization of the ulcer, ligature of the eroded vessel, and mass ligature of the mucous membrane. These are measures of surgical attack of the site of hemorrhage, and formerly were the only ones employed surgically.

The Indirect Method means gastro-enterostomy. The method of its action is to secure both physiologic and physical rest for the stomach _ which not only usually arrests the hemorrhage, but is always helpful to the condition of ulceration which caused it.

It, naturally, goes against surgical feeling, not to directly attack the site of bleeding. The combination of the two procedures probably best covers and corrects both the cause (intragastric condition leading up to the bleeding) and the result (eroded vessel). Mayo Robson's conclusions are as follows: _ "An extensive personal experience and the consideration of a large number of cases operated upon by others, whose work I have had the opportunity of seeing or studying, has convinced me that gastro-enterostomy is a most efficient means of treating hemorrhage from the stomach; and it is only under very exceptional circumstances that I should now think it worth while to open the stomach and treat the ulcer directly. But even if I should deem direct treatment of the bleeding point necessary, I should also think it equally desirable to perform a gastrojejunostomy in order to secure rest to the stomach and to the ulcer, so as at the same time to stop the bleeding and cure the condition giving rise to it. Gastrojejunostomy possesses the advantage that it is applicable to both acute and chronic hemorrhage, that it avoids the necessity of a prolonged search through a gastrotomy opening, that it is quickly performed, and, not least, that it involves little or no shock, and is attended with very small mortality. A collection of a large number of cases of the direct treatment (alone) of the bleeding point not only shows a very heavy mortality but also a want of relief to the condition giving rise to the bleeding in a large proportion of cases."

Sometimes gastrojejunostomy and pyloric exclusion (v. p. 351) are performed.

Direct Operation for Gastric Hemorrhage from Ulcer by Excision, Cauterization, Vessel Ligature, or Mass Ligature.—If the patient has lost much blood, he should be kept especially warm throughout the operation. The stomach should not be washed out in advance _ and measures should be at hand for saline intravenous infusion, or for transfusion, at any moment, before or during operation. If it have been possible to decide that the source of bleeding is distinctly to right or left of the median line, it will be a matter of convenience to make a paramedian abdominal section on the corresponding side – otherwise the abdomen is opened in the median line.

On retracting the abdominal wound, and packing off the field, very careful examination of the stomach and duodenum should be made for the source of bleeding. Unfortunately, the site of hemorrhage is often exceedingly difficult, or even impossible to determine – either before or after the stomach is opened. If some evidence of the site of bleeding can be discovered by examination of the outer surface of stomach, this will determine the place and nature of the gastrotomy wound. An ulcer discovered upon the anterior wall may be directly excised. One located upon the posterior wall may be excised by transgastric excision (v. p. 341). If there be no pathologic guide Rovsing has introduced a diaphanoscope through a small incision in the stomach wall and practised gastroscopy and gastroduodenoscopy. If there be no guide whatever, the stomach is usually incised in its long axis, in about its middle, and about midway between the curvatures – with every provision made to prevent soiling the abdominal cavity. An axial gastrotomy gives the best view, and a vertical incision encounters least hemorrhage. Even then, it may be very hard to locate the bleeding – for it may come from a very small, invisible fissure, or

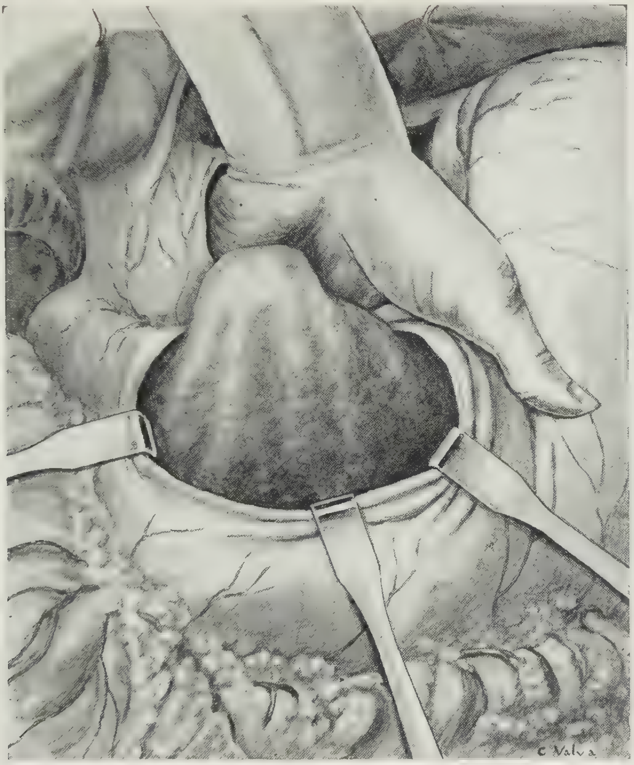


Fig. 3546.—Eversion of the Mucosa of the Stomach Through a Gastrotomy Wound by a Hand Passed Into the Lesser Peritoneal Sac Above, Through an Incision in the Gastrohepatic Omentum.

small erosion hidden in the mucosa, or from an eroded vessel at the base of a calloused ulcer. If the bleeding come from a far end, or from the recess of a curvature, it will be additionally hard to expose. Throughout the manipulations the stomach opening should be so held by retractors, or forceps, that it will be the highest part of the stomach, as the patient lies, so as to avoid leakage. Having opened the stomach by a reasonably free incision, its interior is systematically examined. Considerable help is given in accomplishing this by the eversion of the stomach wall through the gastrotomy wound. This is accomplished either by incising the gastrohepatic omentum, so that a hand in the lesser sac can evert the stomach wall from above (Fig. 3546) – or the gastrocolic omentum may be incised, and a hand passed into the lesser sac from below, to evert the opposite wall (Fig. 3547). Through one or the other of these omental wounds nearly all of the gastric mucosa can be rolled out, in turn. Light reflected from a head-mirror, or an electric cystoscope or proctoscope, may greatly aid in the examination.

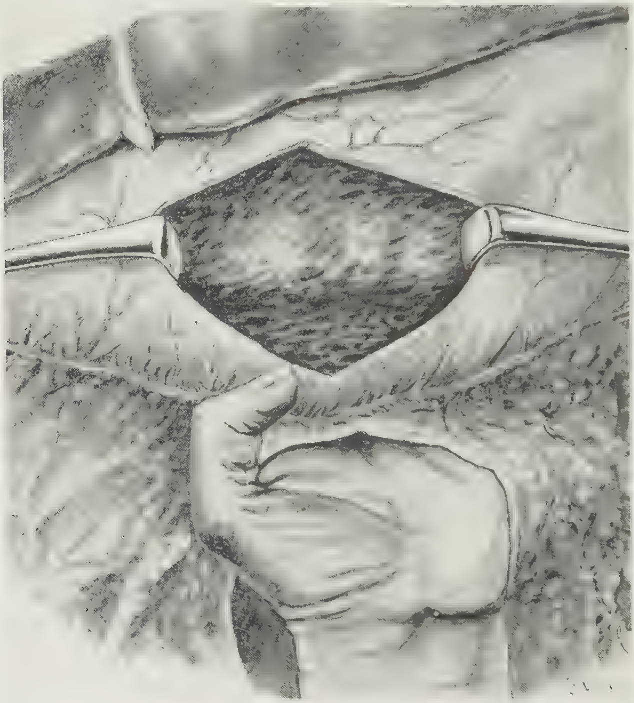


Fig. 3547.—Method of Exposing the Mucosa of the Posterior Wall of the Stomach Following Gastrotomy of the Anterior Wall – By passing the hand through the incised gastrocolic omentum, into the lesser peritoneal cavity and invaginating the posterior gastric wall into the cavity of the viscus – and, if necessary, even on through the anterior gastrotomy wound.

If no gastric ulcer be found, the duodenum is examined by the introduction of a finger, and by eversion.

If no ulcer can be discovered anywhere at all, the conclusion is reached that the bleeding comes from a small undiscoverable ulcer, from a small undetected eroded vessel, or as a capillary ooze, gastrojejunostomy alone is all that can be done, and should be done.

If an ulcer of the stomach be found, one of several methods may be adopted, dependent upon the situation and nature of the ulcer. Elliptic excision, followed by suture, is the ideal method. The marginal suture of fine chromic gut is applied from within (Fig. 3461), and the seromuscular suture of silk or linen, from without (if the excision have involved the serosa). This may be difficult upon the posterior wall, but may generally be managed where it is possible to enter the lesser sac. If the ulcer be in some situation where excision is very difficult or impossible, as in the neighborhood of the cardia, the actual cautery may be used. If the bleeding come from a visible eroded vessel, both ends are picked up by a curved needle threaded with fine catgut and tied. If the hemorrhage be from a small area of mucosa, this may be carefully picked up by forceps and its base surrounded with catgut ligature (mass ligature) _ being careful not to cut through the friable mucosa, with ligature or forceps, and make the bleeding even worse. Nothing but the mucosa must be picked up in the mass ligature.

If the ulcer be at the pylorus, pyloroplasty may be performed _ either the Heinecke-Mikulicz type (p. 285), or the Finney type (p. 287), _ or a pylorectomy may be done, followed by a gastroduodenostomy (p. 357).

The anterior gastrotomy wound, through which the stomach was entered, is now closed by two tiers of suture (as described under Gastrotomy, p. 238).

In extensive operations involving the opening of the lesser sac, gastrotomy and excision of the ulcer _ to say nothing of the possible accompanying gastrojejunostomy _ temporary drainage may be indicated by the special nature of the case.

Indirect Operation for Gastric Hemorrhage from Ulcer _ by Gastrojejunostomy.—Where it is decided to adopt this as the only measure _ or in conjunction with some direct surgical procedure against the ulcer itself _ the posterior gastrojejunostomy is the operation of choice.

In the case of hemorrhage from pyloric and duodenal ulcers which cannot be excised, posterior gastrojejunostomy is indicated, with or without pyloric occlusion _ some Surgeons considering the pyloric exclusion indicated whenever gastrojejunostomy is performed in these cases.

OPERATIVE TREATMENT OF PERFORATION OF GASTRIC AND DUODENAL ULCERS, BY SUTURING, AND ACCOMPANYING GASTROJEJUNOSTOMY, WITH OR WITHOUT ACCOMPANYING PYLORIC OCCLUSION

The occurrence of perforation in gastric ulcer is less common than in ulcer of the duodenum _ but when the former does occur, the region is not so apt to be protected by adhesions _ and the escaping contents are apt to be greater in amount, and not so sterile _ so that general septic peritonitis is more likely to be encountered _ and the perforation is generally found in the midst of an extensive, calloused, friable area which is difficult to close (Mayo).

Although the first operation for acute perforation was only performed in 1880 (by Mikulicz) _ and the first surviving case in 1892 (by Heusner) _ the mortality, which used to be 50 per cent. in operated cases, is now reduced to 5 per cent. _ certainly a most creditable showing.

The frequency with which gastric ulcer perforates has been variously estimated by different Surgeons _ whose ranges extend all the way from 28.5 per cent. to 6.6 per cent.

The sites of perforation of gastric ulcers is interesting _ for although ulcers occur more frequently on the posterior wall, perforations occur more frequently on the anterior wall (usually near the pyloroduodenal junction). The statement of Pariser and Linder (quoted from Mayo Robson) is _ that of 200 ulcers 190 will be upon the posterior wall, and that 4 of these will perforate _ whereas, of 10 on the anterior wall, $8\frac{1}{2}$ will perforate; _ and, according to

Sargent, that in a collection of 77 cases of perforation, 66 of the perforations occurred on the anterior wall and 11 on the posterior.

The only treatment for perforating gastric and duodenal ulcer is operation _ and each hour's delay adds to the mortality. The method of procedure most commonly carried out in these cases is exposure and suture of the ulcer followed or not by gastrojejunostomy (preferably posterior) according to circumstances. Pyloric occlusion (according to the judgment of the individual operator) may be added.

Operation.—If it can be determined by the local phenomena upon which side of the median line the perforation lies, the abdomen is opened by the corresponding paramedian incision, right or left, with retraction of the inner border of the rectus muscle outward _ otherwise, the abdominal section is made in the middle line. Fluid usually escapes as soon as the peritoneum is opened _ and if it be bile stained, one naturally first seeks for the perforation of the duodenum _ otherwise, of the stomach. While the ulcer is generally readily found _ usually lying near the lesser curvature, upon the anterior or posterior aspect _ it may sometimes be exceedingly difficult to locate (see Hemorrhage from Gastric Ulcer, p. 333). The noise of air bubbling through fluid may lead to the site of perforation _ as may also aggregations of adherent and more or less organized lymph, thrown out for protection. Until the site of leakage is located, the soiling of the cavity will, naturally, go on. The soiling may have already become extensive, and require cleansing before proceeding. When once the perforation has been located, and the parts cleansed, gauze packing is carefully made, so as to protect the parts from any future soiling. As soon as the opening is discovered, Moynihan is in the habit of at once preliminarily closing it against further leakage by one or two catgut sutures across its margins. He then has the stomach emptied of its contents by a tube passed down the oesophagus _ which both lessens the likelihood of further leakage and makes the suturing easier.

The site of perforation is now infolded by fine chromic catgut sutures, applied with a curved needle _ which pass through all the coats _ and the first tier of suturing is reinforced by a second tier of interrupted Lemberts through serosa and muscularis _ both tiers extending well beyond the ulcer. Under ordinary conditions of the parts this would be simple _ but, in the presence of ulcer, the adjacent stomach wall becomes infiltrated, inflexible, and friable, so that stitches oftentimes cut right out as soon as sufficient tension is put upon them to tie them. This is always unfortunate _ as it both weakens the site and makes the placing of other stitches even harder. Under such circumstances the method usually adopted is to pass further outward from the center of perforation, and pick up the stomach wall where it is not so infiltrated and friable and is more flexible _ which will, necessarily, make the points of stitch entry further apart and the amount of infolded stomach wall larger. When such difficulty is experienced, it is usually with the first tier of sutures _ when anchorage for these is found no further difficulty for the outlying ones is generally encountered. Mattress-sutures will sometimes hold better than simple stitches. Over the site of suturing an omental graft may be placed and sutured _ and this is particularly indicated if the technic in suturing the site of perforation be questionable.

In the average case of perforation with but limited soiling of the peritoneum gentle but thorough wiping of the soiled parts with gauze wrung out of warm normal saline solution will suffice _ followed by the closure of the abdomen without drainage. If the soiling be more extensive, as may be the case in large perforations and delayed operations, the cleansing will, correspondingly, have to be more extensive. And in those cases where a general peritoneal infection has occurred drainage must be instituted _ which is best accomplished by carrying a large drain (cigar-drain, or split-tube-and-gauze) through a suprapubic incision to the bottom of the pelvic cavity. The cleansing of the cavity is more satisfactorily accomplished by wiping, and by the insertion, removal, and renewal of large gauze pads (taped and clamped) than by intraperitoneal lavage.

Accompanying Gastrojejunostomy.—While an accompanying gastrojejunostomy may be advised by some as a routine procedure in cases of ulcer perforation, its systematic perforamnce in all cases seems both unnecessary and unwise. Moynihan's views upon this subject are as follows: _ If the perforation be of the duodenum, the infolding suturing of the ulcer will, necessarily, be followed by narrowing of the duodenal lumen, so that gastrojejunostomy will be especially serviceable. It is known that more than one ulcer may be present, or that perforation of the second one may shortly follow the closure of the first _ and, in the latter case, a gastrojejunostomy performed at the time of the first operation, would almost certainly make a second operation unnecessary. Moynihan, therefore, advises an accompanying gastrojejunostomy: _ when stenosis has been caused at or near the pylorus, or in the isthmus of an hour-glass stomach, by the operation upon the ulcer; _ when stenosis is apt to follow as a result of the operation and of the pathology; _ or when a second ulcer is present. He condemns the routine performance of gastrojejunostomy in such cases as a solitary perforating ulcer near the cardia or upon the lesser curvature.

It also seems that the performing of pyloric occlusion has been carried on too much as a routine procedure in conjunction with gastro-enterostomy. The need for it in any special case will have to be determined by the individual Surgeon (see p. 351).

Following operation the patient is put to bed in the Fowler position, and is given water by rectum _ and fluids by mouth in small amounts after forty-eight hours if all be well.

Comment.—Moynihan approves of a second washing out of the stomach on the table _ after the stomach is entirely sutured.

The first tier is sometimes a through-and-through tier of interrupted, fine chromic catgut sutures of all the coats _ inverted by a second tier of silk or linen. Occasionally a purse-string suture is first applied, running in and out through serosa and muscularis. Where there is a tendency for the sutures to cut out, Seidel first places a vertical row of heavy, supporting silk sutures, passing through all the coats of the stomach, at each side of the perforation _ after which they are tied loosely enough not to cut out. Closing sutures are then placed horizontally, above and below the perforation _ and when these are tied the traction falls uppon the supporting sutures _ but indirectly bring the margins of the perforation together. And these last are inverted by overlying Lemberts _ or reinforced with an omental graft.

Sometimes the marginal sutures do not include the mucosa.

In some small ulcers excision of the ulcer is the better course _ followed by the usual method of suture (v. s.).

If the operative technic of the immediate wound be unsatisfactory (chiefly because of the friability of the parts) a rubber-tissue-and-gauze drain may be temporarily carried down to it.

In infective peritonitis the suprapubic drainage opening is made upon a finger carried down through the main wound.

Some Surgeons hold that cases do just as well with simple suturing as those in which this is followed by gastrojejunostomy or by gastrojejunostomy with pyloric exclusion.

OPERATIVE TREATMENT OF PERIGASTRIC ABSCESS FROM PERFORATING ULCER OF THE STOMACH OR DUODENUM

The majority of perigastric abscesses occurring in the neighborhood of the stomach are due to perforating ulcers of the stomach or duodenum – and most of the cases arise from chronic ulcers, in which time is usually given for the formation of confining adhesions, which more or less limit the extent of the abscess. But acute or subacute abscesses occasionally occur as a result of limited perforation or imperfect operative technic. Both amount to the same in the end.

The position of an abscess resulting from ulcer will, naturally, be largely influenced by the position of the perforation. The commonset sites are the following: – anteriorly, into the greater peritoneal cavity, extending as a pregastric, subhepatic, or subdiaphragmatic abscess; – posteriorly, into the lesser peritoneal cavity, extending as a postgastric, subgastric, or posthepatic abscess; – or into right or left hypochondrium. Abscesses may rupture upon the surface, into the hollow viscera, or through the diaphragm and into the pleura or pericardium.

Operation.—Three considerations arise in this connection, – the opening of the abscess – provision for drainage – repair of the causative defect.

The position of the abscess is located as well as possible through physical signs and by roentgenography. Incision is usually made either over the site of maximum manifestation of the abscess, or over a site representing the route by which it can be best drained. Owing to the various possible positions of these abscesses the incisions will correspondingly vary – some incisions carrying the Surgeon far afield, such as those exposing the subphrenic and intrathoracic regions.

Drainage is ordinarily accomplished by rubber tubing, plain, or split and with a core of gauze, – or by a core of gauze surrounded with rubber tissue.

The repair of the perforated ulcer-bed has been fully covered under the operative treatment of perforating ulcers of the stomach and duodenum, and may be undertaken at the time of draining the abscess or subsequently.

OPERATIVE TREATMENT OF GASTRIC AND DUODENAL ULCERS BY SIMPLE POSTERIOR OR ANTERIOR GASTROJEJUNOSTOMY

This is the procedure which has been most frequently resorted to – the posterior operation preferably. If the local conditions be such as to make the posterior technic impossible or too difficult because of adhesions, the anterior operation is performed.

The object of gastro-enterostomy is to enable the stomach to pass on its contents by a new opening, and thereby give the ulcer an opportunity to heal by greatly lessening the irritation and traumatism caused by the constant passage of the stomach contents over it – and by decreasing the acidity of the stomach fluids by the addition of alkaline intestinal fluid and bile through the gastro-enterostomy wound.

The details of these operations have been fully given.

ELLIPTIC EXCISION OF A SMALL ULCER OF THE LESSER CURVATURE OR OF THE ANTERIOR WALL OF THE STOMACH

If the ulcer be small, and in such a position as to be easily manipulated, it may be possible to pick it up with half-circular clamps – isolating it from the rest of the stomach – and elliptically excise the ulcer.

To get additional room, in dealing with a saddle-shaped ulcer of the lesser curvature, both the anterior and posterior walls of the stomach can be grasped with vulsellum forceps and drawn upward — to secure "slack" of tissue, as it were, for the application of the isolating clamp.

In applying the clamp to the region of an ulcer of the anterior wall, by elevating the greater curvature, which is readily accomplished, it is comparatively easy to clamp off almost any except the extreme outlying surfaces.

When the special region has been clamped, and the neighborhood protected with gauze packs, the opposite walls of the stomach are held apart by forceps, one by an Assistant, and the other by the Surgeon's left hand, so as to present the ulcer in the center of a relatively flat surface. One side of the excising ellipse is then made with a knife — after which the freed side is is seized with forceps, while the opposite side is severed.

The margins of the wound are then brought together by interrupted or continuous suturing, with fine chromic catgut — after which this tier is buried in by a second tier consisting of fine silk or linen Lemberts (as pictured under the Excision of Gastric Ulcers by the Actual Cautery, p. 345).

OPERATIVE TREATMENT OF ANTERIORLY PLACED DUODENAL ULCER BY EXCISION OF THE ULCER, WITH OR WITHOUT ACCOMPANYING GASTROJEJUNOSTOMY

Simple gastrojejunostomy has been largely employed for these ulcers, and has proved very satisfactory. Moynihan has suggested adding an additional feature to the simple anastomosis of stomach and jejunum, namely, the infolding of the duodenal ulcer, thereby preventing the entry of food from the stomach into the already irritated and ulcerated duodenum. The Mayos blocked the pylorus just above the ulcer for the same purpose — so that obstruction would last long enough to give the duodenum rest and time to heal.

As duodenal ulcers are successfully treated by gastrojejunostomy alone, so may they be treated by excision alone, with equal success. The Mayos, in their first group of 52 operated chronic duodenal ulcers, performed excision without gastro-enterostomy — and with excellent immediate and remote results.

While it is true that duodenal ulcer is cured by gastro-enterostomy alone, it is somewhat contrary to surgical feeling not to directly attack the site of lesion.

Ulcers of the anterior wall of the duodenum, therefore, may, in suitable cases, be excised — and, in the judgment of William J. Mayo — "The excision of the ulcer should be accompanied by the division of the pyloric sphincter, using either the Finney or the Heinecke-Mikulicz method of pyloroplasty in the closure. The gastroduodenal opening should be made at least 2½ inches in length."

TRANSGASTRIC EXCISION OF ULCERS OF THE POSTERIOR WALL OF THE BODY OF THE STOMACH

BY THE MAYO TECHNIC

Ulcers of the posterior wall of the stomach may often be exposed by incising either the gastrohepatic or gastrocolic omentum and directly exposing the site of the ulcer. In some cases even adhesions with the pancreas may be freed in exposing such an ulcer.

In other instances it is easier to expose and excise an ulcer of the posterior wall through an incision made in the anterior wall.

The technic of the transgastric exposure is as follows: — Having opened the abdomen and brought the stomach into the field, the gastrohepatic omentum is incised above the lesser curvature, and the gastrocolic omentum is incised below the greater curvature. Access to the lesser peritoneal cavity is thus secured, and, through this approach the posterior wall of the stomach is freed from any adhesions which may be binding it _ and, if possible, the ulcer itself is separated from its posterior attachments by blunt or sharp dissection, without opening the stomach. A substantial gauze strip is carried through the lesser cavity, entering and emerging through the cut omentum (as shown in Fig. 3548) _ and has usually sufficed to control bleeding without requiring the ligation of vessels. This packing also protects the surrounding region from soiling.

An incision is now made through the anterior wall of the stomach. In the case of a small ulcer and simple conditions, a vertical gastrotomy ordinarily suffices _ but in larger involvements and complicated cases, an axial gastrotomy, through a relatively non-vascular area, is preferable. If it have been possible to mobilize the ulcer, the Surgeon's left finger-tips passed into the lesser sac, will be able to deliver it through the retracted lips of the anterior gastrotomy wound (Figs. 3546 and 3547). It is now elliptically excised, carefully guarding the fingers which are protruding it forward. If, at this stage, the Surgeon's left hand is replaced by the Assistant's hand, the Surgeon will be able to more conveniently make the excision by steadying the margins of the ulcer with forceps during the act.

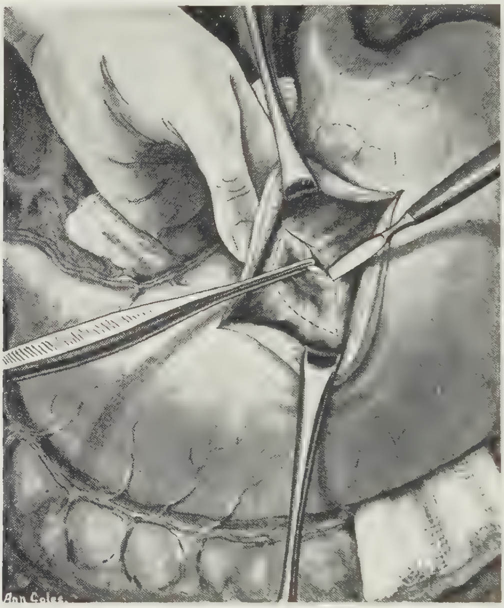


Fig. 3548.—Transgastric Excision of an Ulcer of the Posterior Wall of the Body of the Stomach _ By the Mayo Technic _ I; _ The gastrohepatic and gastrocoloic omenta have been incised, and a strip of gauze carried through the lesser cavity, behind the stomach. An axial anterior gastrotomy has been performed _ the lips of the stomach wound retracted _ and the ulcer of the posterior stomach wall, delivered through the anterior wound by the pressure of fingers in the lesser sac, is being excised by means of knife and forceps.

If the ulcer has not been freed from its posterior attachments, so as to enable the above maneuver to be fully carried out, the anterior wall of the stomach is depressed until in contact with the posterior wall _ after which the ulcer is excised from within the stomach — sometimes necessitating the paring off of a thin layer of pancreas in the procedure.

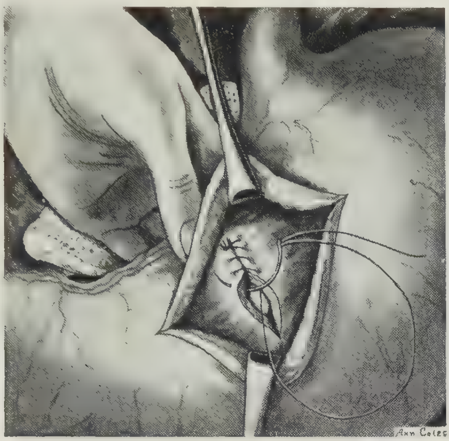


Fig. 3549.—The Same — II; — **The ulcer has been excised** — and the margins of the **wound, protruded** forward by fingers in the lesser sac, are being sutured with through-and-through stitches, as the **first tier.**

The margins of the wound are transversely sutured, from the mucous side, with through-and-through stitches of chromic catgut (Fig. 3549). The first suture line is further protected by several mattress-sutures of linen,

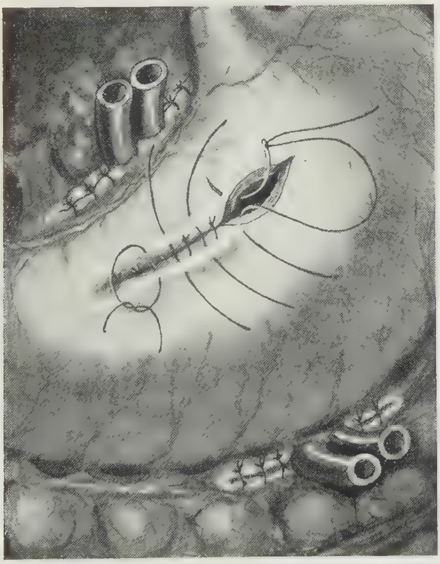


Fig. 3550.—The Same — III; — The anterior gastrotomy wound is being sutured — **drains have been** carried behind the stomach, through the lesser sac — and the gastrohepatic and gastro**colic omenta sutured** up to the drains.

applied from the mucosa, to protect the wound from the early absorption of the catgut. (It would seem that it would be better to make the second tier of suturing consist of Lembert's, through the serosa and muscularis, applied from the outside _ provided the posterior aspect of the wound can be exposed through the opening in either the gastrohepatic or gastrocolic omentum.)

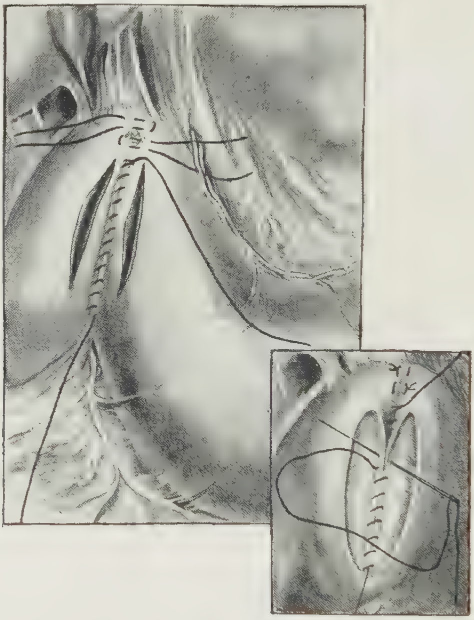
The anterior gastrotomy wound is closed by a through-and-through tier of fine chromic catgut _ reinforced by seromuscular Lemberts (continuous or interrupted) of silk or linen _ as shown in the illustration (Fig. 3550).

In concluding the operation a couple of folded rubber tissue drains are conducted through the omental openings behind the stomach _ and their outer ends carried through one end of the sutured abdominal wound as temporary safety drains.

OPERATIVE TREATMENT OF ANTERIORLY PLACED, HIGH-LYING DUODENAL ULCER BY INFOLDING OF THE ULCER AND BY ACCOMPANYING GASTRODUODENOSTOMY

BALFOUR'S OPERATION

In this technic, as applied by Balfour, the pylorus is not interferred with, nor is any use made of the calloused ulcer to form any portion of the posterior wall of the anastomosis. The ulcer is especially avoided, and the gastroduodenostomy is made altogether in normal tissue.



Figs. 3551 and 3552.—Operative Treatment of Anteriorly Placed, High-lying Duodenal Ulcer, by Infolding of the Ulcer, and by Accompanying Gastroduodenostomy _ Balfour's Operation _ I and II: _ A, Mattress-sutures placed ready to infold the ulcer, and the sites of incision into duodenum and stomach marked; _ B, the infolding mattress-sutures of the ulcer are shown, and the posterior tier of the gastroduodenostomy sutures. (Redrawn from Balfour.)

The lesion is supposed to be a chronic ulcer, whose excision is not considered safe and where pylorectomy is considered too great an operative risk. Two forms of operation will be cited.

The pyloric end of the stomach and the duodenum are exposed _ and mobilized. Two mattress-sutures are so placed as to infold the ulcer (Figs. 3551 and 3552. Corresponding lengths of duodenum and stomach are calculated for approximation and for the anastomosing incisions. A posterior row of interrupted seromuscular silk sutures is first placed. In front of this a second tier of continuous seromuscular sutures of chromic catgut is placed, extending slightly above and below the preceding, through the cut margins of serosa and muscularis. The mucosa of duodenum and stomach is then incised _ the margins brought together by through-and-through fine chromic catgut _ after which the marginal seromuscular chromic catgut tier and the interrupted seromuscular tier which were begun behind are continued and completed in front. Clamps are not employed _ but the field is well packed off. Traction sutures, as originally used by Finney (and shown in the illustration), are employed.

It will be noticed that the anastomosis is here made below the high-lying duodenal ulcer. But a duodenopyloric ulcer might be sometimes so placed as to make this impossible _ and, in such a case, the anastomosing incisions into stomach and duodenum could be placed laterally to, and in front of, the ulcer _ so that, on suturing, the ulcer would be excluded from the field, but would be at the same time infolded.

OPERATIVE TREATMENT OF POSTERIORLY PLACED DUODENAL ULCER, EITHER BY COMBINED EXCISION AND SUTURING OR BY GASTROJEJUNOSTOMY

In those cases of posteriorly placed duodenal ulcers where no adhesions exist, the mechanical problem of sufficient exposure for manipulation is not so great. But in many instances the involved duodenum is fused, by adhesions, with the pancreas _ so that its posterior wall is inaccessible. In several such cases as these last William J. Mayo approached the ulcers through a transduodenal incision. Through this incision he excised the ulcers from their mucous aspect, and sutured together the resulting margins of the ulcer bed as well as could be done from within the intestinal lumen. As the usual protective seromuscular tier of sutures could not be placed in the ordinary manner, only one such stitch was placed at the upper and at the lower peritoneal angles.

In 1 of 4 cases operated upon he completely divided the duodenum, after excising the ulcer _ and then directly united the end of the duodenum to the end of the stomach.

In another instance he applied devitalizing mattress-sutures from the mucous aspect of the duodenum so as to cut out the ulcer.

His summary of these cases was, however, that the operations were so difficult that gastro-enterostomy was, by comparison, a simpler procedure _ and that excision should be reserved for ulcers of the anterior duodenal wall.

OPERATIVE TREATMENT OF ULCERS OF THE LESSER CURVATURE AND ANTRUM OF THE STOMACH BY ACTUAL CAUTERY AND ACCOMPANYING GASTROJEJUNOSTOMY

BALFOUR'S TECHNIC

Failure of cure has frequently been observed following the simple excision of ulcers of the lesser curvature, even though no pyloric obstruction existed. This is explained through Forssell's demonstration of the importance of the gasrtic tendon of the lesser curvature. This is based upon the observation that the greater curvature, corresponding in musculature with the situation of the ulcer upon the lesser curvature, is often permanently involved by the ulcer _ and crippled even after the excision of the ulcer, gastric motility being impaired because of interference with the nerve supply which results from extensive excisions made along the lesser curvature. When, however, an accompanying gastro-enterostomy was performed, success followed in a much larger number of cases. In a number of patients in the Mayo Clinics in whom the ulcer was simply excised _ without a simultaneous gastro-enterostomy, subsequent gastro-enterostomy became necessary. So that the latter operation is now generally performed immediately following the operation upon the ulcer.

Two deaths occurred in the second week following simple excision of gastric ulcers _ as a result of continuous hemorrhage _ the patients doing well between the operation and the beginning of hemorrhage. When gastro-enterostomy was performed it was too late _ and the postmortems showed that bleeding had not come from definite vessels, but that the mucosa had failed to unite, and had widely retracted _ leaving the muscularis exposed, which later was the source of bleeding.

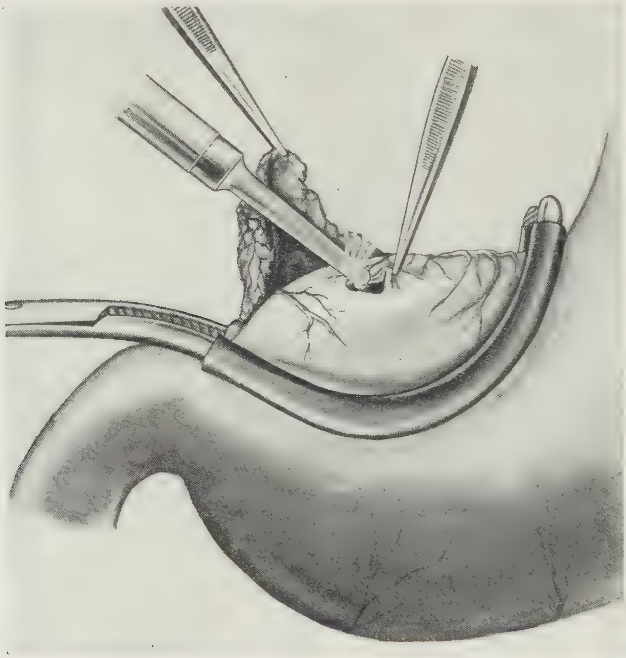


Fig. 3553.—Operative Treatment of a Small, Accessible Ulcer of the Stomach _ Either by Cauterization or Excision, Followed by Inturning by Suturing _ I; _ Part of the gastrohepatic omentum, interfering with the field, has been temporarily displaced _ and a controlling, half-curved clamp has been applied, to isolate the area. (Figs. 3553–3555 modified from Balfour.)

Balfour then began a method of destroying the ulcer by actual cautery _ which he employed in certain cases _ and by which several objects were accomplished. These objects are: _ the difficulty of closing the site of an excised ulcer of the lesser curvature (which is greater than the excision itself) is made easier, _ hemorrhage, early or late, is practically prevented, _ separation of the mucosa is prevented, _ any initial malignancy present is destroyed, _ the innervation is far less apt to be injured because of the small amount of tissue removed, _ and so little tissue is destroyed that minimum contraction results. The technic amounts, in reality, to a cautery excision of minimum dimensions, and progressing from the focus outward rather than by an elliptically circumscribing incision of the ulcer site.

The operation is performed as follows: _ The site of ulcer is exposed and its nature and extent determined by inspection and palpation. The peritoneal and muscular coats of the stomach are incised over the ulcer _ and dissected back as a flap (Fig. 3553). The Paquelin cautery point, at dull red heat (juts hot enough not to stick), is slowly pushed through the ulcer until an artificial perforation is made, and all of the surrounding calloused tissue is heated until the actual site of the ulcer is destroyed by moderate burning. As to the closure, Balfour writes: _ "The opening is then closed by interrupted sutures of chromicized catgut, reinforced by mattress-sutures of silk. The reflected gastrohepatic omentum is then replaced over the site by superficial interrupted sutures of fine silk." His illustration (Fig. 3554), however, gives the impression of simple interrupted Lembert sutures of the muscularis, burying in the first tier of sutures. The final suturing of the peritoneal margins and the anchorage of the gastrohepatic omentum over the wound are shown in Fig. 3555.

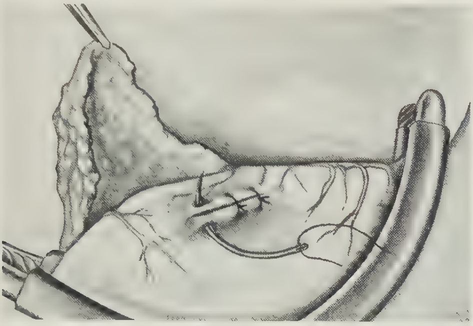


Fig. 3554.—The Same _ II; _ The margins of the wound are being brought together by through-and-through chromic catgut sutures _ after which this layer will be buried in by Lembert stitches of linen or silk.

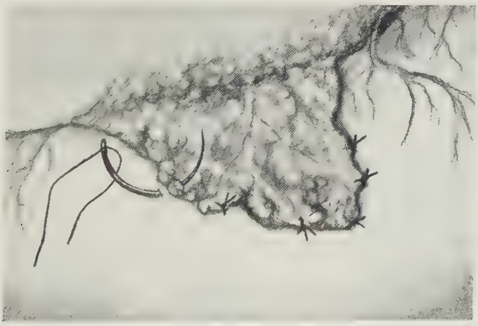


Fig. 3555.—The Same _ III; _ The temporarily detached gastrohepatic omentum is brought over the doubly sutured wound, and anchored in position for additional protection.

Gastrojejunostomy is then at once performed _ preferably by the posterior emthod _ unless prevented by adhesions, which may necessitate the adoption of the anterior technic.

WEDGE-SHAPED EXCISION OF AN ULCER OF THE LESSER CURVATURE OF THE STOMACH WITH OR WITHOUT ACCOMPANYING GASTROJEJUNOSTOMY

Description.—The principle of the present operation is the excision of a wedge-shaped segment of the stomach _ the V-shaped mass including both walls of the stomach, with its base lying along the lesser curvature and including the ulcer, and the sides of the triangle extending in the direction of the greater curvature and so planned as to meet as short a distance below the ulcer as compatible with satisfactory approximation of the wound margins by suture (too great a depth of the sides causing too great subsequent constriction of the stomach).

While simple gastrojejunostomy will often effect a cure of pyloric and duodenal ulcers, those upon the lesser curvature and posterior wall are not so apt to be cured by that means alone _ and, therefore, excision of these saddle-shaped ulcers is the usual method of procedure.

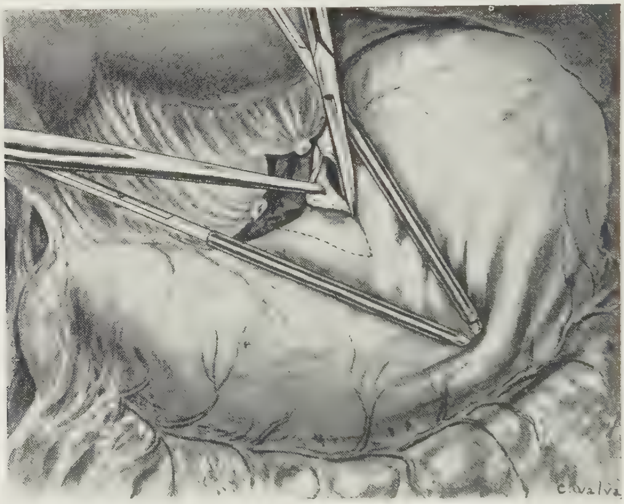


Fig 3556.—Wedge-shaped Excision of an Ulcer of the Lesser Curvature With or Without Accompanying Gastrojejunostomy _ I; _ The isolation of a triangular portion of both walls of the stomach, including the saddle-shaped ulcer of the lesser curvature, preparatorily to excising the ulcer and the wedge-shaped piece. The coronary artery and vein have been ligated and divided on each side _ and the gastrohepatic omentum incised, and its bleeding vessels ligated. The posterior blade of each clamp passes into the lesser peritoneal cavity.

Some Surgeons perform a simple excision _ and others accompany the excision by an immediate gastrojejunostomy, as an accompanying step. This is a matter of surgical judgment _ the safer plan probably being the combined operations _ (see General Considerations, p. 329).

Preparation _ Position _ Landmarks.—As in gastrojejunostomy (q. v.).

Operation.—The abdomen is best opened by a right paramedian incision. The stomach is exposed and the ulcer and its surroundings thoroughly investigated, especially as to the question of adhesions, and the involvement of adjacent organs. The region of operation is packed off with gauze pads. Ligate and divide the coronary artery and vein on each side of the field of operation, carrying the ligature around them with an aneurysm needle _ and divide the gastrohepatic omentum corresponding with the immediate field, ligating its divided vessels. The base of the wedge of stomach to be removed will include the corresponding lymphatic glands lying along that part of the lesser curvature. Pass one or two fingers into the lesser peritoneal cavity and draw the posterior aspect of the stomach upward and forward, thus better exposing the site of operation _ while packing large gauze pads into this region for protection against soiling. Two straight rubber-covered clamps are now applied, calculating that enough room will be given between them both for the satisfactory removal of the ulcer bed and the easy suturing of the resulting margins. These clamps must not be compressed sufficiently to devitalize their beds. One blade of each clamp passes into the lesser sac behind the stomach, and the opposite blade, upon its anterior aspect. The points of the clamps will meet below the region to be excised, at the apex of a triangle, whose base is formed by the lesser curvature between the handles of the clamps _ thus isolating a triangular portion of anterior and posterior stomach wall. Especial care is exercised not to include too much of the stomach wall toward the greater curvature. A shallow triangle of both walls of the stomach, with the ulcer as the center of its base, is excised (Fig. 3556) _ which is best accomplished by making successive short snips with straight scissors along the predetermined lines. There will be some outpour of stomach contents during the section, to be caught upon the pads _ but the bleeding and the major part of the possible soiling will be controlled by the clamps.

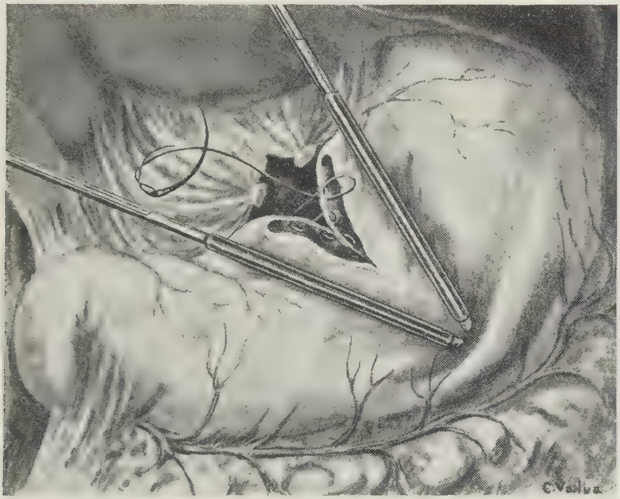


Fig. 3557.—The Same _ II; _ The ulcer-bearing, V-shaped segment of the lesser curvature and underlying stomach has been excised _ and the first line of continuous loop-on-the-mucosa suturing is being applied.

After cleansing the parts, and repacking the wound, or reinforcing the original packing, the clamps are brought together, so as to render the margins parallel and accessible for suturing. The suturing is done with a curved needle in a holder, filled with fine chromic catgut or fine Pagenstecher linen _ which is introduced as a continuous loop-on-the-mucosa suture (Fig. 3557). The suture begins upon the mucous aspect of the posterior wall at the apex of the triangle _ passing from the mucosa through all the coats of one side _ enters the stomach again through all the coats of the opposite margin, from serosa to mucosa _ then passes, from mucosa to serosa, through all the coats of the same side (3 mm., or $\frac{1}{8}$ inch from its last penetration, and the same distance from the free edge) _ after which it passes over to the opposite edge, where it again enters the stomach by passing through all the coats 3 mm., or $\frac{1}{8}$ inch away from its original point of penetration, from serosa to mucosa _ and here it is tied upon the mucosa as a starting point. This continuous stitch, with alternate loops upon the mucosa of opposite sides of the wound, is continued on upward to the lesser curvature _ and then on down the mucous aspect of the anterior surface, to the apex of the anterior triangle, where it is tied. This suture infolds the mucosa and, at the same time, approximates the serosa in very accurate fashion.

The clamps are now removed and the parts wiped off with gauze dipped in normal saline solution. Any vessel found bleeding is ligated. The first row of suturing is reinforced by a second tier of interrupted, or continuous Lembert sutures, of fine Pagenstecher, or silk, which is begun posteriorly and ended anteriorly. The gauze pads are removed from the lesser cavity and the gastrohepatic omentum is sutured back into place. Sometimes a temporary cigarette drain is introduced into the lesser sac, along the posterior wall of the stomach, and brought out over the lesser curvature, and out through the upper angle of the wound. The abdomen is then closed.

Instead of the above form of suturing, the margins may be first brought together by a tier of interrupted sutures passed through all the coats and knotted on the mucous aspect of the stomach _ after which this line may be reinforced by interrupted Lemberts passing through serosa and muscularis.

In those cases where it is decided to perform an accompanying gastrojejunostomy it is carried out as soon as the stomach is sutured _ and after a complete change of instruments, gloves, and gowns.

OPERATIVE TREATMENT OF PYLORIC ULCER BY PYLORECTOMY AND ACCOMPANYING GASTRO-ENTEROSTOMY

RODMAN'S OPERATION

The pyloric aspect of the stomach bearing the ulcer is severed from the duodenum and from the major portion of the stomach, both of which are guarded by clamps. The open end of the duodenum and of the stomach are then closed by suture _ after which a posterior gastrojejunosotmy is performed, as seems to be the general preference _ or a gastroduodenostomy.

The operation is especially indicated where there are multiple ulcers _ where the ulcer is a large, complicated one _ or where there is strong suspicion of cancer.

The details of the operation are, essentially, the same as those employed in the corresponding operation for cancer (q. v.) _ except that the same necessity for removing the stomach so wide of the growth does not exist _ nor is it necessary to remove the lymphatic glands. The duodenum need not be removed unless the seat of ulcer _ and it is not usually necessary to sacrifice as much of the lesser curvature.

OPERATIVE TREATMENT OF LARGE ULCERS OF THE BODY OF THE STOMACH BY PARTIAL INTERCARDIOPYLORIC EXCISION, FOLLOWED BY UNION OF THE CARDIAC AND PYLORIC ENDS ("SLEEVE OPERATION"), ACCOMPANIED, OR NOT, BY GASTRO-ENTEROSTOMY

The operation here designated is practically the same in principle and execution as the corresponding operation for cancer of the center of the stomach (see chapter heading _ except that it need not be so rigorously carried out along some of its lines (such, for instance, as the free removal of glands, the furnishing of wide margins of sound tissue, and the like).

The ulcer lies in the middle of the vertical strip of the stomach excised within the doubly clamped-off area.

The gastro-enterostomy is either a gastroduodenostomy or a gastrojejunostomy.

PYLORIC OCCLUSION, EMPLOYED TOGETHER WITH GASTROJEJUNOSTOMY, IN THE TREATMENT OF GASTRIC AND DUODENAL ULCERS

By pyloric occlusion or exclusion is meant the blocking of the pylorus, in order to force food out of the stomach through a gastro-enterostomy opening, and divert it from passage through its normal channel, thus securing functional rest to the occluded part. The basis of this technic is the observation, made upon animals, that when gastro-enterostomy is performed, and the pylorus left open, most of the food continues to leave the stomach by the pylorus.

The strict indications for pyloric occlusion have not been accurately formulated – and there are many practical Surgeons who consider that average cases do just as well after simple gastrojejunostomy as they do following combined gastrojejunostomy and pyloric occlusion.

Pyloric exclusion has been employed in conjunction with gastrojejunostomy for such purposes as the following: – to force food to leave the stomach by the gastrojejunostomy opening, thereby keeping it patulous, – to prevent the passage of irritating food and fluids over ulcerated surfaces in the pyloroduodenal region, – and to prevent vicious circle.

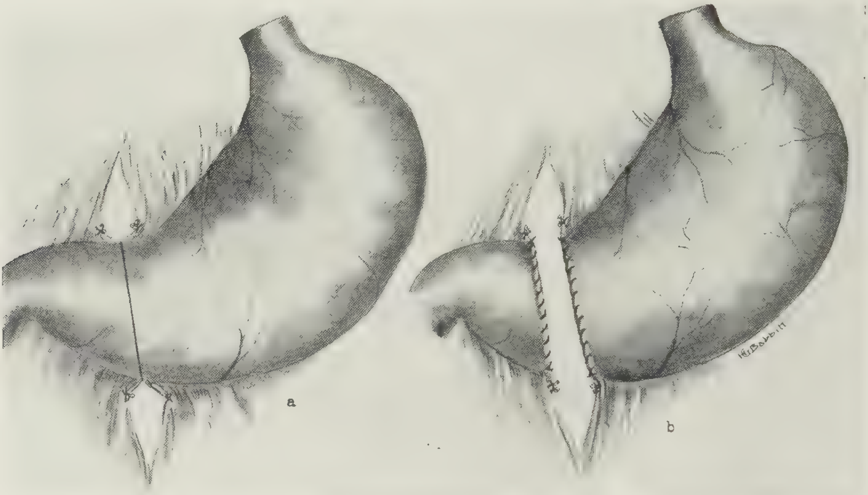
While enthusiastically practised by some Surgeons, it is considered by others to be an unnecessary complication.

A number of methods of bringing about occlusion of the pylorus or duodenum have been employed. In some of the methods the lumen is simply closed, the closure often being but temporary, – while in others the parts are disconnected, and the blocking of the passage is, therefore, absolute. The pylorus may be closed or disconnected – or the duodenum may be closed or disconnected. Some of the more commonly applied methods will be mentioned.

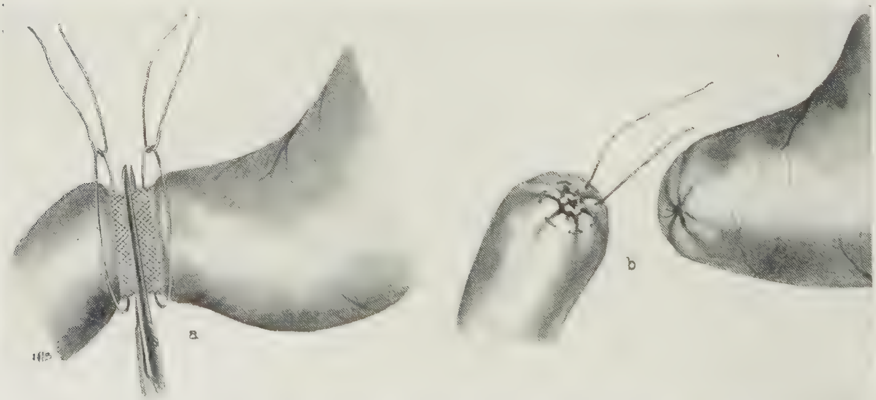
Radical Pyloric Exclusion by Disconnection (Von Eiselberg's Technic). —This is the most radical of all the procedures, and is, of course, absolute and permanent. The method, however, is now rarely used, as the procedure is a very considerable one, as compared with simpler ones. The stomach is divided upon the oral side of the ulcer after which, both ends are turned in by suturing. The gastrohepatic and gastrocolic omenta are incised opposite the line along which the stomach is to be divided – and the stomach is doubly clamped across the interval, and divided between them. The free edges of both the cardiac and pyloric aspects of the stomach are then separately sutured by through-and-through chromic catgut sutures, after which this tier is turned in by overlying Lemberts of serosa and muscularis. The technic is diagrammatically shown in Figs. 3558 and 3559.

Radical Duodenal Exclusion by Disconnection (Bier's Modification of Von Eiselberg's Technic).—In this modification of the above operation the pyloroduodenal region is exposed – after which it is first crushed with a Doyen angiotribe, and doubly ligated in the crushed tract. The parts are then divided – and then inverted by Lembert sutures (or by purse-string) into their own aspects of stomach and duodenum (Figs. 3560 and 3561).

Pyloric Occlusion by Infolding (Kelling-Mayo Technic).—A double row of parallel silk or linen sutures is passed proximally to the site of ulcer – dipping beneath the serous coat at intervals – so that when tied the pyloric wall will be doubled inward upon itself in corrugations. When there are no adhesions posteriorly, this double line of sutures is continued all around the pyloric region — dividing the gastrohepatic and gastrocolic omenta to gain access. If this cannot be done, they are merely passed into the wall of the anterior aspect of the stomach. This method is shown in Figs. 3562 and 3563. It is known that these sutures frequently cut through, eventually, and the pylorus again becomes patulous. Three or four parallel sutures are sometimes employed.



Figs. 3558 and 3559.—Radical Pyloric Exclusion by Disconnection — Von Eiselberg's Technic: — **a**, The pyloric aspect of the stomach, after having been doubly clamped — the clamps (not here shown) passing through the incised gastrohepatic and gastrocolic omenta, is divided between them, along the line indicated; — **b**, the doubly sutured cardiac and pyloric ends of the stomach.



Figs. 3560 and 3561.—Radical Duodenal Exclusion by Disconnection — Bier's Modification of Von Eiselberg's Technic: — **a**, The pyloroduodenal region has been crushed with Doyen's angiotribe, and is being doubly ligated in the crushed tract, preparatorily to being divided between the ligatures; — **b**, the ligated duodenal end is being inverted by purse-string suture — and the ligated gastric end is being invaginated by Lemberts.

Pyloric Occlusion by Ligation.—A heavy linen (Pagenstecher) suture is carried around the pylorus, passing, at intervals, through the serosa and into the muscularis, to hold its position _ after which it is tied just tightly enough to occlude the pylorus, without cutting into the coats of the stomach When this is accomplished, to reinforce the method, it is well to place a few

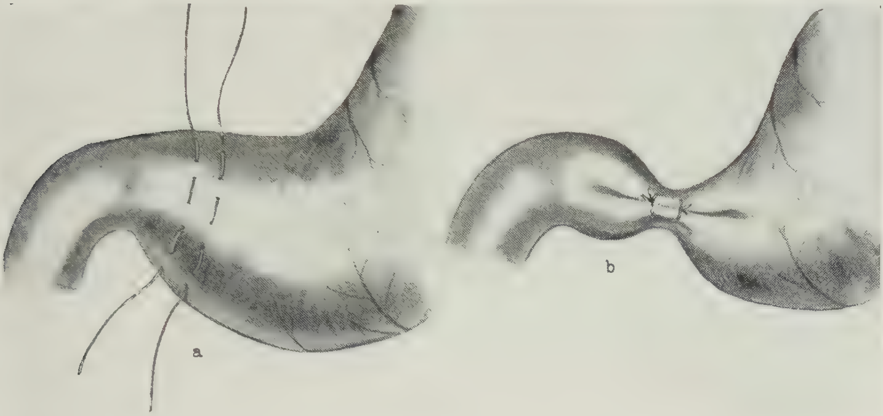
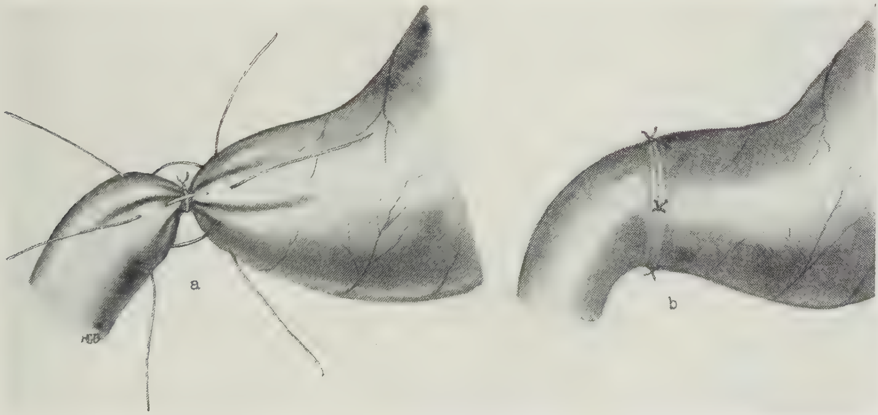


Fig. 3562 and 3563.—Pyloric Occlusion by Infolding _ Kelling-Mayo Technic: _ **a**, Two parallel sutures, dipping beneath the serosa at intervals, are passed, here, through the anterior wall of the antrum of the pylorus (and, similarly all around it, if the posterior wall be accessible); _ **b**, the appearance of the pyloric antrum after tying the sutures.

Lemberts in such a way as to bury in the constricting suture. The technic is shown in Figs. 3564 and 3565.

Many other methods of blocking the pylorus and duodenum have been employed: _ Parlavecchio uses a cotton tape instead of thread; _ Wilms transplants a free portion of the fascia lata, and uses this as a constricting band; _



Figs. 3564 and 3565.—Pyloric Occlusion by Ligation: **a**, The constricting ligature; _ **b**, the site of the tied ligature reinforced by Lemberts.

Polya has used the round ligament of the liver instead of thread, for constriction; _ Biondi circularly divides the pylorus, through serosa and muscularis, and peels them back from the mucosa, after which he doubly ligates the mucosa and divides it between the ligatures, carbolizing the stumps of mucosa – and then the margins of serosa and muscularis are closed (and may be reinforced by Lemberts), – and other methods.

OPERATIVE TREATMENT OF GASTROJEJUNAL ULCERS

The nature of these ulcers – which follow gastro-enterostomy in about 3 per cent. of the cases – has been described, as far as it is known, at p. 311.

In order to do all that is known to be done to avoid them, only absorbable material is used in suturing the immediate gastro-enterostomy opening, in the Mayo Clinics. (The stay sutures of silk, employed to tack the outlying limbs of intestine to the stomach, are at some distance from the actual gastro-enterostomy opening – v. p. 307.)

In regard to the treatment of this class of ulcers no definite operative technic has been worked out – each case being met as indicated when encountered. The general plan followed in the Mayo Clinics is to expose the site of the original gastro-enterostomy – either by a transgastric or transjejunal incision – and then locate the ulcer and find, if there be present, the retained suture – after which the thread, if any, is removed and the ulcer excised – sometimes the entire gastrojejunostomy being excised. When the anastomosis is constricted and can be safely enlarged, this is done. Where there is much induration and infection, excision of the gastrojejunostomy site – closure of the gastric and duodenal openings – and gastrodudenostomy are indicated.

In other quarters, a second gastrojejunostomy by Roux' method *en Y* is performed, after excision of the old stoma.

OPERATIVE TREATMENT OF CANCER OF THE STOMACH, IN GENERAL

Gastric carcinoma is the most frequently occurring form of cancer of the human body. And yet, infrequency of early recognition and prompt operation are responsible for a large part of the present death-rate. And further, it was only in 1881 that the first successful operation for cancer of the stomach was performed by Billroth, who evolved, then, the operative technic which is even now the most generally adopted in these cases.

In an analysis of 1000 cases operated upon for cancer of the stomach in their Clinics, William J. Mayo made some interesting observations: – 378 were resections – 246 palliative operations – and 376 exploratory operations. The conclusion reached was that diagnosis early enough to secure a radical cure by operation cannot often be made – but that the diagnosis of some surgical condition, probably cancer, can be made early enough to make operation possible in more than one-third of all cases (*i. e.*, in 378 out of the 1000).

Cancers of the pyloric end of the stomach occurred in 75 per cent. – and of the body and fundus in 25 per cent. of the cases. Wilson and MacCarty, investigating 218 cancers of the stomach operated upon in the Mayo Clinics, found, "that ulcer, or some primary lesion of a similar character, had existed in more than 50 per cent."

A conclusion reached in the above extensive works was that every operation for cancer of the stomach should be begun as an exploratory operation – and that to give the patient the best chance exploration must be made early.

MacCarty and Blackford, working in these same Clinics, noted that the relative order of the degree of involvement of the lymphatic groups was as follows: – (1) The lesser curvature group – (2) the inferior pyloric group – (3) the greater curvature group – (4) the superior pyloric group. In removing the lymph-nodes ligation of the four blood-vessels of the lesser and greater curvatures is the starting-point and renders the operative field relatively dry.

As a result of experience in these Clinics, it was concluded that the best general type of operation of partial excision of the stomach, with restoration of the gastro-intestinal tract, was the Billroth Method II – in which the duodenum is completely closed, and a coil of the jejunum is anastomosed with the stomach, preferably by the posterior route (posterior gastrojejunostomy). In some cases, especially where the resulting stomach is small, anterior gastrojejunostomy is performed – with apparently equally satisfactory results, and with less technical difficulty. In some exceptional instances of very much lowered vitality the gastro-enterostomy was performed two or three weeks in advance – and the radical operation later (though in all cases of choice, this procedure was less favorably considered than the completion of both details at the one *séance*). Gastrostomy, performed with a No. 16 English catheter by the Witzel method (v. p. 266), was often found serviceable in cancer obstructing the cardiac end of the stomach. In obstruction of the pyloric end of the stomach anterior gastro-enterostomy, by the method of Woelfler and Hartmann, was considered the operation of choice, on the basis of its requiring less manipulative disturbance than the posterior operation (which was associated with a higher mortality) – vicious circle, according to their observation, not being encountered as a result of the anterior technic – and the method furnishing an average mortality of less than 4 per cent. Jejunostomy (for feeding, and for rest to the stomach) was sometimes found useful where the cancer was situated so high up, posteriorly (often with perforation), that a radical operation could not be performed – the jejunostomy being made by the Witzel method, from a coil taken 12 to 16 inches below the duodenojejunal junction, with a No. 12 English catheter.

The final conclusions, in connection with the above investigations, was that cancer of the pyloric end of the stomach could be recognized sufficiently early to make radical operation possible in at least one-half of the cases – and that the mortality is about 10 per cent., dependent, largely, upon the grade of case accepted for operation – the mortality being less than 5 per cent., if the patient's condition be good, – that there is a prospect of a five-year cure in about 25 per cent. of the cases – and a three-year cure in about 38 per cent. – in those patients who recover from the operation, – and that comparatively few patients who recover from the excision fail to get more than one year of relief.

Kroenlein and Mikulicz modified the Billroth Method II so as to directly anastomose a long loop of jejunum directly to the cut end of the remaining portion of the stomach – Kroenlein using the whole lumen of the cut end of the stomach for anastomosis with the long loop of jejunum – and Mikulicz closing the upper two-thirds of the stomach opening and then performing a button-anastomosis between the jejunal loop and the lower portion of the stomach opening.

Polya, after excising the involved portion of the stomach, sutured the margins of the lumen of the remaining end to a corresponding length of the antimesenteric aspect of a loop of jejunum, about 6 to 12 inches from the duodenojejunal junction.

Balfour, of the Mayo Clinics (as quoted from the writings of Lewisohn), modified the Polya technic, by employing the anticolic route rather than the retrocolic route of gastrojejunostomy – using a loop of jejunum taken about 14 inches from the plica duodenojejunalis (in spite of the objections, more or less substantiated, of the long-loop, anticolic route). According to Lewisohn, Balfour reports the following statistics of the results of different operative technics at the Mayo Clinics: – 318 cases operated upon by the Billroth Method II, with 13.2 per cent. mortality – 104 cases by the Polya method, with 14.4 per cent. mortality – and 38 cases by the Balfour method, with 5.2 per cent. mortality.

Following partial gastrectomy, union of the cut proximal end of the duodenum with the remaining portion of the stomach is more physiologic, of course, than the anastomosis of the stomach remnant with any part of the jejunum – and in spite of the fact that Kocher, especially, has satisfactorily accomplished this after extensive mobilization of the duodenum, by incision of the peritoneum over the right kidney, the extent of distance to be spanned is often so great, after the removal of any considerable part of the stomach, that the resulting tension upon the sutures of anastomosis is generally too great to be safe.

Schlatter, in 1897, performed the first successful total gastrectomy – which by some has been considered to have been a subtotal, rather than a total gastrectomy, and this denied by others. (Lewisohn states that the pathologic findings in Schlatter's case showed that, in excising the stomach, he had divided the duodenum and the esophagus – which, of course, constituted a total gastrectomy). Cormor had first attempted total excision of the stomach – the patient dying. Since the initiation of the operation, Flechtenmacher has collected 36 cases of total gastrectomy. (See Total Gastrectomy.)

Cancer of the median portion of the stomach without involving the pylorus is exceptional – whereas cancer beginning in the pylorus frequently extends until three-quarters of the stomach are involved.

Lymphatic extension from the originating cancerous center is more apt to be a contraindication to operation than the mere question of size of the tumor, if confined to its original environment – as large tumors are often very easily removed, and *vice versa*. Gussenbauer and Winiwarter (again quoting from Lewisohn) showed, by autopsy, that in 542 operations for gastric carcinoma, the growth was local in 223 cases, without any metastases.

Adhesions to adjacent structures, particularly in the case of the pancreas, are often of inflammatory nature – and generally do not present insuperable barriers. It has been shown in the Mayo Clinics that a superficial layer of the pancreas may be sliced off in such cases. But if the adhesions involve the pancreas deeply, or the middle colic artery be involved, radical operation is generally contraindicated – although simultaneous partial gastrectomy, with total excision of the transverse colon, has been carried out, but with very high mortality.

Peck, of New York, reported in 1916 a group of 527 cases of cancer of the stomach to the Surgical Service of several of the larger Hospitals of New York City during the preceding five or six years – which especially emphasized the non-early recognition and surgical action in this category of cases. An analysis of this group of cases showed the following interesting features: – 71 per cent. of the patients were males, and 29 per cent. females; – the late and hopeless stage of disease in which a high percentage of the patients were when admitted to Hospital for relief ("The one glaring fact which stands out in studying this group," as Peck put it); – of the total number, 408 were subjected to operation – "and in 119 no operation was done, for the most part because of the advanced stage of the disease, although a small number refused surgical treatment"; – of the 408 operated cases, 143 were exploratory, in which the stage of advancement prevented further procedure; – in 167 palliative gastro-enterostomy or gastrostomy was performed; – "And in only 98 cases was an attempt at a radical operation made. Even in this latter group many of the cases were very far from being examples of the early stage of the disease and offered little hope of permanent cure with radical excision."

PYLORECTOMY FOR GASTRIC CARCINOMA, FOLLOWED BY END-TO-END GASTRODUODENOSTOMY

BILLROTH'S METHOD I

Description.—The pylorus is excised, with as much of the adjacent stomach and duodenum as may be involved. The large opening left in the pyloric end of the stomach is then closed, in part, by suture – from the lesser curvature toward the greater, until a gastric opening is left along the greater curvature, corresponding in size with the cut end of the duodenum – after which the gastric and duodenal openings are anastomosed, end to end, by simple suturing. The scheme of the operation is shown in Fig. 3566.

This method is usually less desirable than Method II (p. 362). And see Comments, p. 360 – as well as Operative Treatment of Cancer of the Stomach, in General, p. 354.

Preparation – Position.—As for Gastro-enterostomy, (q. v.).

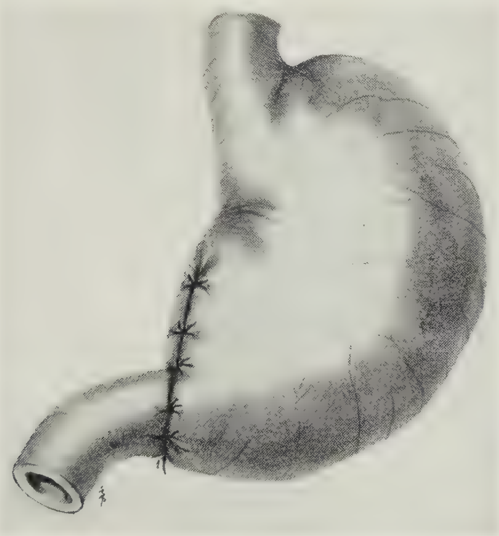


Fig. 3566.—The Scheme of Billroth's Pylorectomy, Method I; – Showing the sutured gastrectomy wound, and the end-to-end gastro-enterostomy, at the greater curvature.

Landmarks.—The right rectus muscle.

Incision.—Vertical, over the inner third of the right rectus, beginning a short distance beneath the costal arch and extending downward to or below the level of the umbilicus. Various incisions have been used: – A median incision, which does not so readily expose the parts; – An obliquely transverse incision 10 to 12.5 cm. (4–5 inches) long, having one-third of its length to the left, and two-thirds to the right of the linea alba, and crossing that line obliquely downward from left to right, between the xiphoid cartilage and umbilicus, Billroth's original line, which necessitates much transverse division of muscle, though better exposing the parts.

Operation.—The abdomen is opened as in the right paramedian section (p. 130). Control hemorrhage, and retract the margins of the wound. The site of the operation is carefully located and packed off with gauze – slight adhesions being broken down by blunt dissection – and the parts brought as well forward into the wound as possible. The lesser and greater omenta are ligated off along the area corresponding with the parts to be removed ‒ by gut ligature carried by an aneurysm needle, or Cleveland ligature-carrier ‒ along the upper and lower borders of the pyloric end of the stomach and duodenum (Fig. 3567). As soon as freed from omental attachment, the contiguous portions of the stomach and intestine are to be packed off with especial care from the general cavity and adjacent structures with gauze.

Two clamps are now placed upon the duodenum, parallel with and about 2 cm. ($\frac{3}{4}$ inch) apart, on either side of the line to be incised. Two are similarly placed upon the stomach about 2.5 cm. (1 inch) apart. The lines of incision are so calculated that they will be more or less parallel. The duodenum is first divided between the clamps with scissors or knife. All leakage is carefully caught and the interior of the free end of the gut cleaned. The stomach is then similarly dealt with (Fig. 3567). The excised portion is now removed. The free ends of the stomach are brought well forward and abundant packing placed posteriorly. The clamps are retained as convenient means of aiding in the manipulation of the parts. In order to provide a lumen of stomach at the pyloric end which will correspond with that of the duodenum all that portion of the cut edges of the stomach in excess of the required lumen is closed (Fig. 3568). This is done by a continuous overhand chromic gut suture

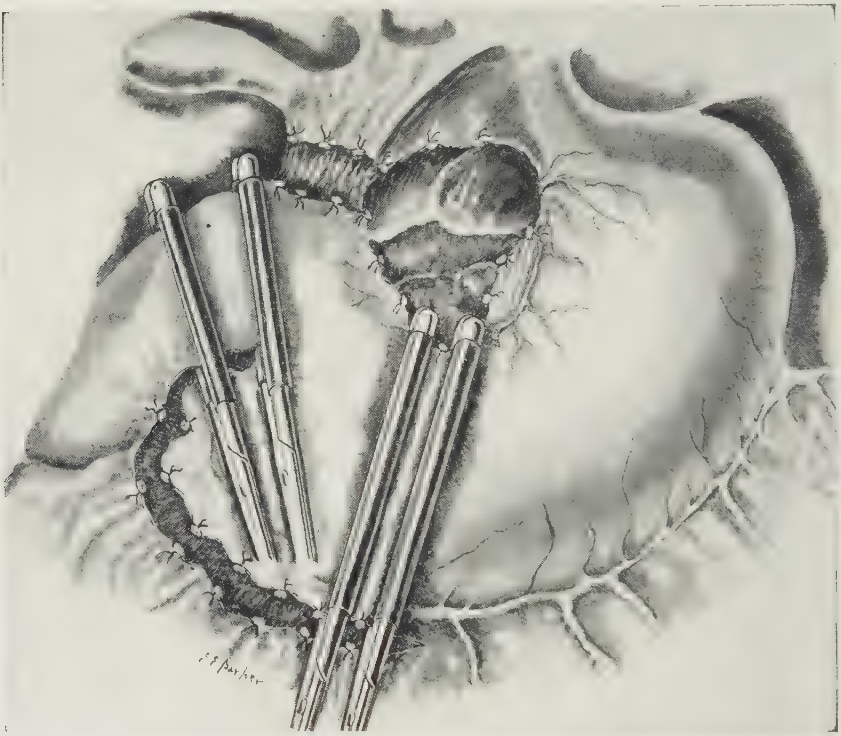


Fig. 3567.—Pylorectomy for Gastric Cancer, Followed by End-to-end Gastroduodenostomy ‒ Billroth's Method I ‒ A; ‒ The right and left gastric vessels have been ligated and the lesser omentum incised along the lesser curvature ‒ and the right and left gastro-epiploic vessels ligated and greater omentum incised along the greater curvature ‒ after which the duodenum and the stomach have each been doubly clamped, preparatorily to excising the portion between the two outside clamps, the sections running near to the outer borders of the two inner clamps, so as to leave tissue for suturing.

including all the coats of both edges of the stomach. It begins at the lesser curvature and is carried downward the required distance – leaving unsutured, next to the greater curvature, a lumen of stomach which will correspond in size with the opposite lumen of duodenum. A line of continuous or interrupted silk or linen Lembert sutures immediately buries in this first line of silk suturing, passing through the serous and muscular coats of the stomach, on either side of the first suture line and thus invaginating it.

The free edges of the openings in the duodenum and stomach are then approximated by an assistant who holds them in apposition by means of the clamps. By means of a continuous or interrupted chromic gut suture including all the coats of intestine and stomach the duodenum is sutured to the remaining opening in the stomach – the parts being so turned as the suturing progresses as to present the entire circumference (Figs. 3568 and 3569). This line of sutures is chiefly for strength. The line of continuous circular suturing just applied is immediately followed by a second tier of silk or linen Lembert sutures passing through serous and muscular coats of both viscera, thereby burying in, by invagination, the first tier. This second line of suturing is chiefly for occlusion. The clamps being relaxed and all parts being thoroughly

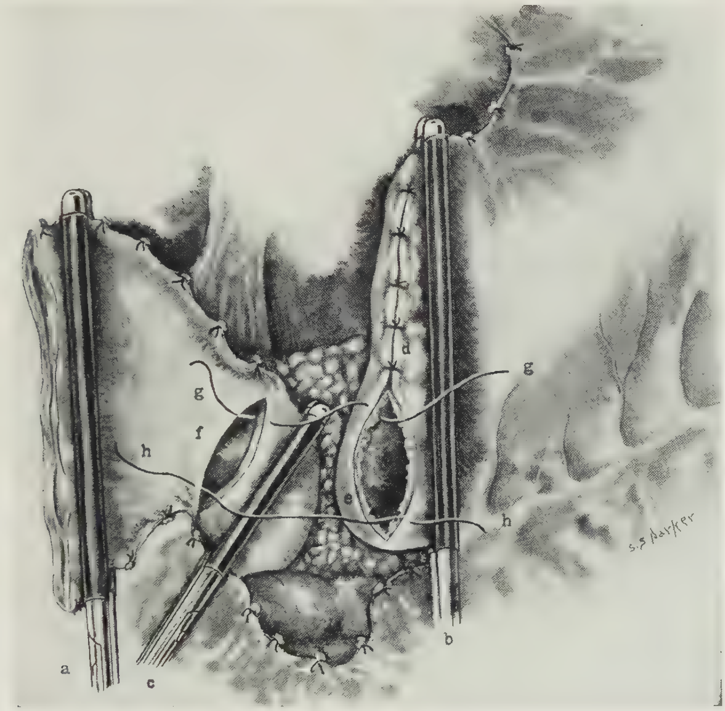


Fig. 3568.—The Same – B: – **a,** The divided pyloric end of the stomach is turned outward, to the right, exposing the posterior aspect of its duodenopyloric junction; **b,** the divided cardiac end of the stomach, clamped, has been doubly sutured, from the lesser curvature, down sufficiently to leave a marginal opening corresponding in size with the incision to be made at the duodenopyloric junction; **c,** clamped duodenal aspect of the duodenopyloric junction; **f,** transversely incised duodenum; **e,** unsutured opening left at the incised end of the stomach; **g, g,** position of posterior marginal sutures; **h, h,** position of anterior marginal sutures. These are generally continuous. The posterior seromuscular (placed first) and the anterior seromuscular suturing (placed last) is inserted in the usual manner (v. Figs. 3568–3570).

cleansed, the lesser and greater omenta, which had been previously ligated and detached, are now resutured with gut to the upper and lower borders of the attached stomach and duodenum. The parts are then dropped back into place and the abdomen closed.

The completed anastomosis is seen in Fig. 3570.

Comments.—Only as much of the gastrohepatic and gastrocolic omenta are ligated as may be necessary for the exposure and clamping of the segment to be removed, and the former should be ligated rather near to the liver, so as to remove the corresponding glands. In ligating the gastrocolic omentum the ligatures are placed between the gastro-epiploic artery and the transverse colon — thus also securing the wide removal of these glands. In ligating along the greater curvature especial care should be exercised not to include the middle colic artery.

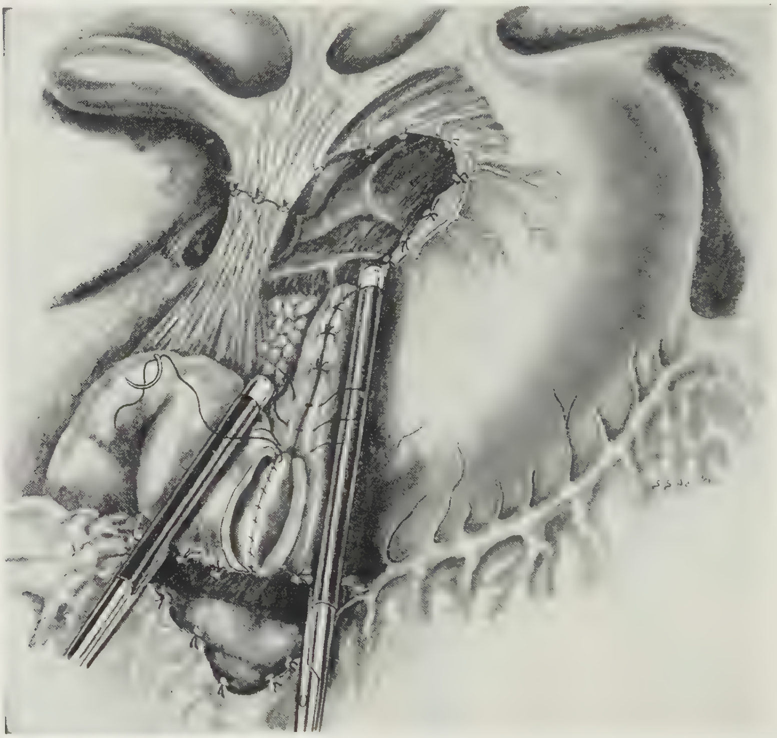


Fig 3569.—The Same — C; — The excess of stomach opening, from lesser curvature downward, has been closed by a double tier of sutures — leaving a gastric opening at the greater curvature, corresponding in size with the cut end of the duodenum — the two being now anastomosed by two tiers of suture, constituting the gastroduodenostomy.

The clamps entering and emerging from the incised gastrohepatic and gastrocolic omenta should safely, evenly, and securely clamp the stomach. The two stomach clamps should be about 2.5 cm. (1 inch) apart, and the two duodenal clamps the same distance — and the inner one of each set of clamps need not be rubber covered (as the clamped part is discarded) — for, in this way, when the sections are made close to the inner clamp of each set, ample tissue is left extending beyond both remaining clamps for convenient and safe suturing.

When the division of the stomach nearer the cardiac end is made, that portion is then turned, by means of the clamp, out of the way, to the left, while the duodenal end is being freed and divided. The pyloric and right gastro-epiploic arteries are ligated — but the gastroduodenal artery is preserved from harm, so as not to interfere with the blood-supply to the descending duodenum and to the head of the pancreas.

It may require considerable care to free the duodenum, if adhesions be marked, before it can be doubly clamped for section — but is always easier after the first section of the stomach between the set of cardiac clamps.

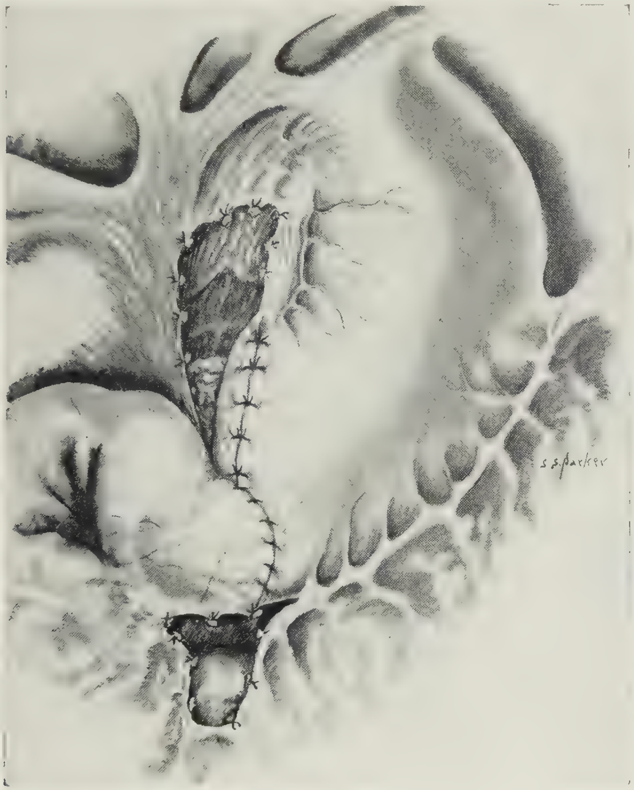


Fig. 3570.—The Same — D; — The completed operation — except that the omental openings remain to be closed by suture.

The section of stomach and duodenum may be made by knife, scissors, or actual cautery.

No opening should be left in the incised gastrohepatic and gastrocolic omenta for the possible engagement of coils of intestine — the gap in each being sutured to the corresponding site of the gastroduodenal anastomosis.

The anastomosis has been made by the Murphy button.

A serious difficulty which may arise in connection with this one of the two methods of Billroth is the difficulty sometimes experienced — especially where mobilization of the parts cannot be readily accomplished — of making the end of the duodenum reach the site of gastric anastomosis without too much tension. Leakage in the "deadly angle" of anastomosis has also occurred.

PYLORECTOMY FOR GASTRIC CARCINOMA, FOLLOWED BY POSTERIOR AND LATERAL GASTROJEJUNOSTOMY, AND WITH OR WITHOUT ACCOMPANYING JEJUNOJEJUNOSTOMY

BILLROTH'S METHOD II

Description.—The pyloric portion of the stomach is excised, and the opened ends of the stomach and duodenum are closed by a double tier of sutures. After this a loop of the upper jejunum is anastomosed, side-to-side, with either the posterior or anterior wall of the closed stomach, to the cardiac side of the closed end – posterior gastrojejunostomy being preferable where it can be carried out. Finally, jejunojejunostomy is usually performed between the ascending and descending limbs of the jejunal loop which has been anastomosed with the stomach. This technic is shown, schematically, in Fig. 3571. The loop of jejunum has also been anastomosed directly with the lower end of the opening left unsutured for the purpose, in the restoration of the partial gastrectomy – but the method is not as satisfactory as the one just mentioned. Pylorectomy, with anterior gastrojejunostomy, is shown in Fig. 3575.

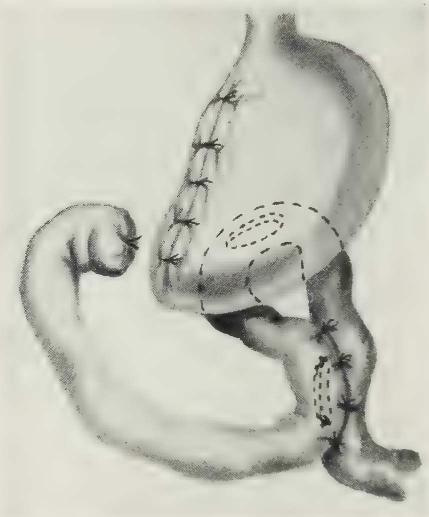


Fig. 3571.—Pylorectomy for Gastric Carcinoma, Followed by Posterior Lateral Gastrojejunostomy, with Accompanying Jejunojejunostomy – One of the alternative technics in **Billroth's** Method II – A – 1; – Scheme of the technic.

The Billroth Method II, with or without some minor modification, stands as the most generally employed manner of performing pylorectomy. The operation, as carried out in careful detail by Edward H. Taylor, will be here given.

Preparatory Measures.—The patient is gotten into the best condition for the operation that circumstances will allow. Peptonized milk and nutrient enemata are sometimes indicated. The teeth are put into good shape, and the mouth kept clean. In dilated stomachs, with collections of fermented contents, the stomach is lavaged for several days in advance. In very weak and emaciated patients the gastro-enterostomy is done two or three weeks in advance – and the partial gastrectomy later.

Incision.—The abdomen is opened by a vertical incision of about 10 cm. (4 inches) – placed just to the left of the median line, and extending to or below the navel. (This, presumably, is a paramedian incision, with outward retraction of the rectus muscle.)

Operation.—On entering the abdomen the stomach and its surroundings are carefully examined, and a conclusion reached as to the warrantable steps. The anterior wall of the stomach is exposed by elevating the liver and depressing the transverse colon. The posterior wall may be examined by an incision in the gastrohepatic omentum – and another in the gastrocolic omentum (far enough from the greater curvature not to wound the gastro-epiploic vessels) – through which the fingers of both hands may be introduced into the lesser peritoneal sac and the posterior stomach wall palpated (as shown in Fig. 3449). One examines for metastases in neighboring structures (especially the liver) – for adhesions (especially between the posterior wall of the stomach and pancreas) – and as to the general mobility of the stomach and pyloroduodenal region – and the nature and extent of the growth. If palpation do not suffice, the gastrocolic opening should be increased, and the postgastric region exposed to sight as well as touch. It should be determined to what extent, if any, the lymphatic glands be involved, particularly those along the curvatures of the stomach and below the pylorus – remembering that not all enlarged glands are malignant, while some normal appearing glands are.

Adhesions and extension of involvement into the transverse mesocolon (without actual involvement of the transverse colon itself) may be found. This generally indicates the wisdom of abandoning a radical type of operation – but, if not, not only must the involved part of the transverse mesocolon be removed but also the corresponding part of the transverse colon itself (whose blood-supply would be otherwise cut off). When these examinations have been completed, the wisdom or non-wisdom of continuing the operation will be determined. If decided in the affirmative, and more room be required, the original incision may be increased as far as necessary. All bleeding is controlled. The involved structures are packed off with gauze pads wrung out in warm normal saline solution. The skin margins are protected with gauze, or "tetra wipes," clamped in place.

The omenta are now ligated and divided. Three or four ligatures, carried upon an aneurysm needle (or Cleveland ligature-carrier), are passed through the gastrohepatic omentum in sections (Fig. 3572) as near the liver as possible, generally beginning near the cardia, and passing to within 2.5 cm. (1 inch) of the right end of the lesser omentum (the extent of omentum ligated being determined by the extent of cancerous involvement). These ligatures are tied, and the omentum divided between them and the stomach, but above the coronary artery. At the right end of the division of the lesser omentum the pyloric artery is ligated as it descends to the lesser curvature – and the gastroduodenal artery is exposed and ligated as it passes downward between the duodenum and head of the pancreas – the vessels being exposed largely by blunt dissection. The ligation and division of the gastrocolic omentum is accomplished in the following manner: – A hand is carried downward, posterior to the stomach and pylorus, through the incised gastrohepatic omentum, and the great omentum pushed forward upon the fingers – thereby separating it from the underlying transverse mesocolon, with its vessels (upon which the integrity of the transverse colon depends) – so that they are saved from injury. In the same manner as accomplished in the case of the lesser omentum, a line of segmental ligatures is carried through the greater omentum and tied – extending from a point below the pylorus, to a point corresponding with the center of the greater curvature, and so placed as to lie safely below the lymphatic glands of this curvature, and the omentum is cut above them. The left gastro-epiploic vessels are tied opposite the middle of the greater omentum. If adhesions between the stomach and pancreas make this maneuver impossible, the transverse colon is lifted out of the abdomen and the mesocolon and its middle colic artery closely observed while the greater omentum is being ligated and divided. The freed stomach can now be displaced forward and protected with warm, moist gauze pads.

The duodenum is next divided. Guarded by a finger behind the pylorus and duodenum, two parallel clamps are applied to the duodenum distally to the growth, and about 2.5 cm. (1 inch) apart. The distal one of the two clamps is forcibly closed, while the proximal one is rubber covered and moderately closed. The distal clamp is then relaxed, and the crushed flattened tract of duodenum strongly ligated with catgut _ after which the duodenum is divided between the ligature and the proximal clamp. (If the shortly clamped end of the stomach show a tendency to slip through the grasp of the clamp, Moynihan's method of passing a suture through the lips of the stomach and tying it around the clamp may be employed.) The duodenal stump is inverted by a purse-string suture, or by Lemberts, into the lumen of the duodenum (Fig. 3573).

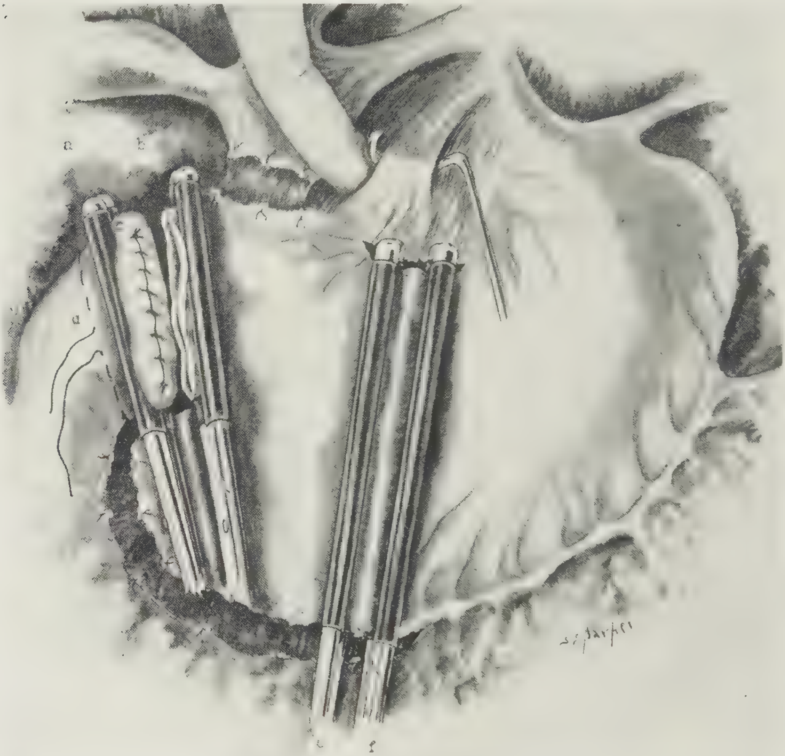


Fig. 3572.—The Same _ A–2; _ The gastrohepatic and gastrocolic omenta have been ligated in segments, and divided _ an aneuryism needle, guided by a finger in the lesser omental cavity, is carrying-on this ligaturing of the gastrohepatic omentum: **a**, Clamped end of the divided duodenum, whose free edges have been closed by marginal suture, **c**; _ **d**, purse-string suture, ready to be tightened, after the invaginiation of the free end of the duodenum; _ **b**, clamped pyloric aspect of the stomach; _ **e**, **f**, parallel gastrc clamps, between which the stomach will be divided.

The gastrojejunostomy is now performed. The clamped stomach is displaced forward and to the left — the clamp serving as a handle, as it were (Fig. 3573). If this step be halted by posterior adhesions, they are separated by blunt dissection, or, if necessary, a thin layer of the pancreas may be sliced off with a knife (the resulting hemorrhage being controlled by pressure or ligature). When the stomach is drawn to the left, the falx coronaria is made tense, and the coronary artery is brought into the field, lying between the two folds of the lesser omentum. It is ligated near its origin by needle and ligature passed beneath it, and again about 1.2 cm. ($\frac{1}{2}$ inch) further to the left — and the vessel and ligament divided between the two ligatures. The stomach

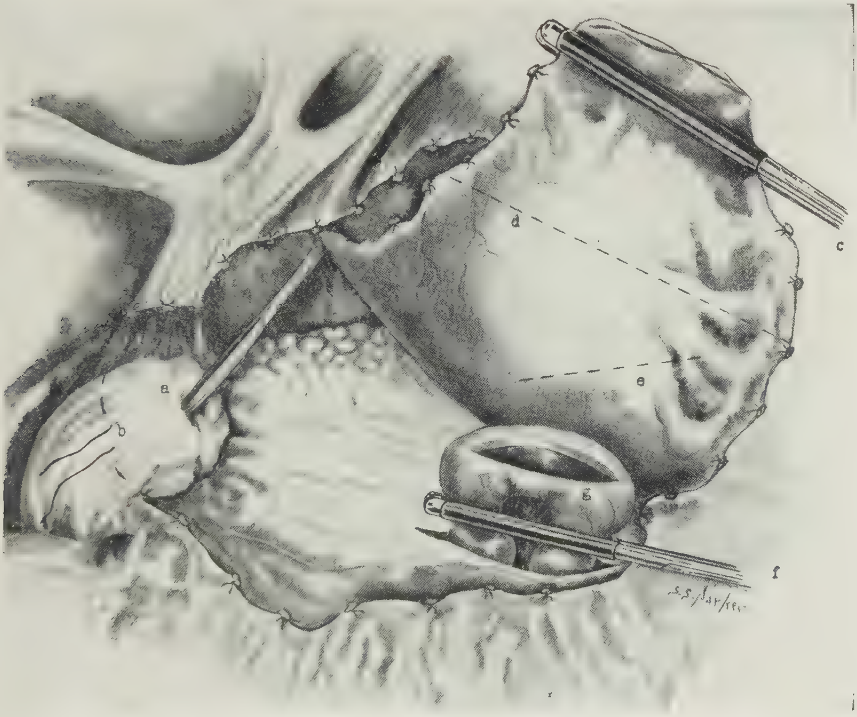


Fig. 3573.—The Same — A–3: — **a,** The free end of the duodenum is being invaginated; — **b,** purse-string, about to be tightened upon the invaginated end of the duodenum; — **f,** jejunal loop, brought through the incised mesocolon; — **g,** incision in the loop of jejunum, preparatorily to anastomosing it with the posterior wall of the stomach; — **c,** clamped pyloric end of the stomach; — **d,** line along which the pyloric aspect of the stomach will be excised, distally to a clamp which will be placed proximal to the line of section; — **e,** site at which the posterior wall of the stomach will be excised for the posterior gastrojejunostomy.

is thus freed nearly to the esophagogastric junction — and may be further displaced outward and forward. With gauze upon the finger-tip, loose strands of tissue and lymphatic glands are wiped away from the site of the celiac axis. At this junction the posterior gastrojejunostomy is performed — and its performance is made easier by the manipulation of the stomach through the hold the clamp has upon it. An incision is made in the posterior layer of the gastrocolic omentum (which has been lying upon a mass of small intestines during these latter steps) and a coil of jejunum, as near the duodenojejunal junction as possible, is drawn through, and is so clamped as to enable this coil to be conveniently approximated to the posterior wall of the stomach preparatorily to the anastomosis which is to take place along the lines indicated in Fig. 3573, **e.** It is very important to see that the site for the incision into the stomach will lie sufficiently to the left of the line along which the stomach will be finally divided, to give plenty of room for the safe inversion of the stomach margins of the remaining cardiac end of the stomach. The posterior gastrojejunostomy is then accomplished in the same general manner as described under that operation (v. p. 302).

The proximal section of the stomach is placed safely to the cardiac side of the growth, and extends from the lesser to the greater curvature, along the line indicated in Fig. 3573, **d.** Preliminarily to making this section, two parallel clamps are made to compress the anterior and posterior walls of the stomach, one on each side of the line of stomach section, as shown in the illustration the blades of the proximal (cardiac) clamp being guarded by rubber tubing. In order to prevent the stomach from possibly slipping through the cardiac clamps, the stitch is seized with a pair of small clamp-forceps at its lesser curvature, and by another at its greater curvature, just distal to and immediately alongside of the cardiac clamp, or Hertel's forceps may be used to reinforce the ordinary clamps (Fig. 3442). The stomach is then divided between the clamps, close to the distal clamp, so as to leave ample stomach wall for inversion. The cancerous portion of the stomach and its two clamps are removed. The margins of the stomach are first closed by a chromic catgut suture through and through all the coats (which also controls bleeding from these edges) after which this marginal line is inverted

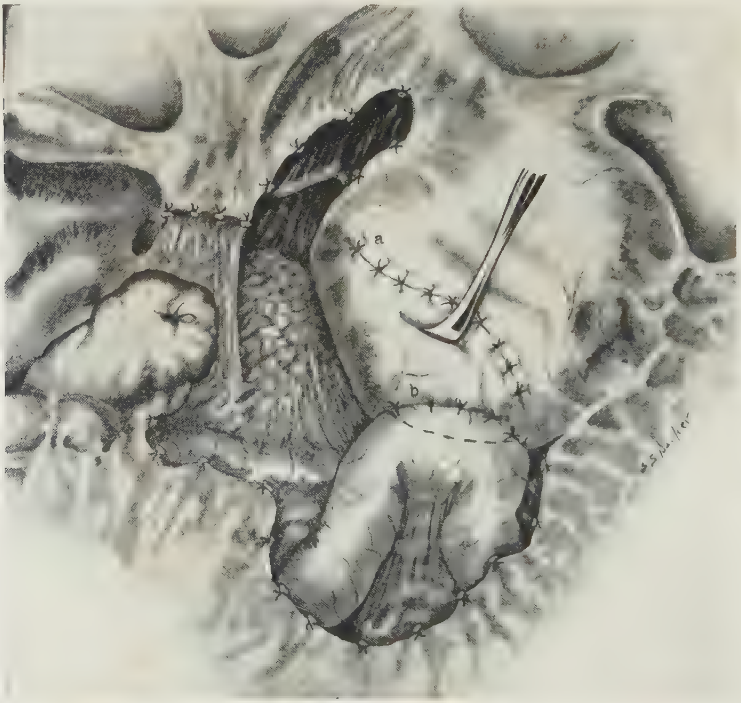


Fig. 3574.—The Same A–4; The completed operation: **a,** The line of terminal suture of the stomach; **b,** line of posterior gastrojejunostomy, between a loop of the jejunum and the incised posterior wall of the stomach.

by a seromuscular linen or silk suture (Fig. 3574). Some Surgeons first bring the mucosa together by a separate layer of catgut suturing. If any vessels are found bleeding in the cut margins they should be tied with fine catgut before the suturing begins.

All remaining lymphatic glandular tissue is sought for _ and is removed by dry sponging with gauze-mops. These are especially the subpyloric and the right suprapancreatic glands _ the latter being dealt with carefully owing to their relationship with the hepatic artery.

The jejunojenostomy is now finally performed by probably the majority of Surgeons _ (though not mentioned in Taylor's detailed description). It is carried out in the usual manner (as described at p. 302).

At the end of the operation all incised or separated portions of omenta are carefully sutured back into place, or together, or are so anchored as to leave no opening for possible strangulation of coils of intestine.

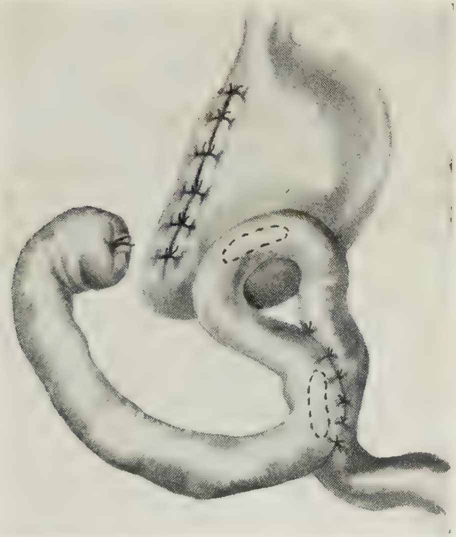


Fig. 3575.—Pylorectomy for Gastric Carcinoma, Followed by Anterior Lateral Gastrojejunostomy, and Accompanying Jejunojejunostomy _ Alternate Technic of Billroth Method II _ B-1; _ Scheme of the technic.

Postoperative Care.—Nourishment is entirely rectal for some days _ after which peptonized milk is given by mouth _ and eggs added on the seventh day.

Pylorectomy, Followed by Anterior Lateral Gastrojejunostomy, and Accompanying Jejunojejunostomy _ Alternate Technic of Billroth Method II (Fig. 3575).—The pyloric aspect of the stomach is excised exactly as in the preceding operation _ as to the division and closure of the duodenum and the division and closure of the stomach. Then, instead of uniting a coil of jejunum, taken from very near the duodenojejunal junction to the posterior stomach wall, a coil of jejunum a little lower down is taken, and is brought up around, in front of, the transverse colon and anastomosed with the anterior aspect of the stomach _ the technic as to the steps of anastomosis being the same as in Woelfler's anterior gastrojejunostomy, p. 302. The appearance of the parts, upon completion of the operation, is as shown in Fig. 3576.

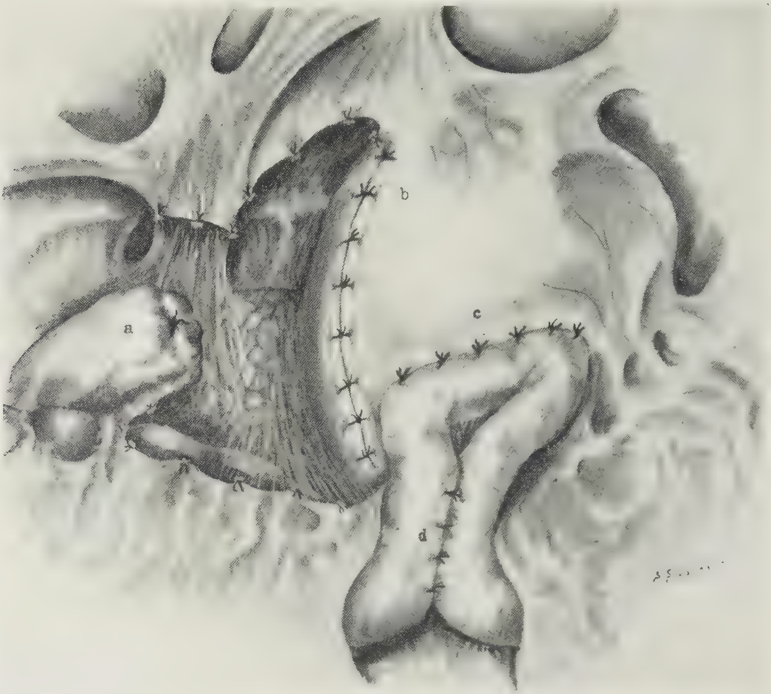
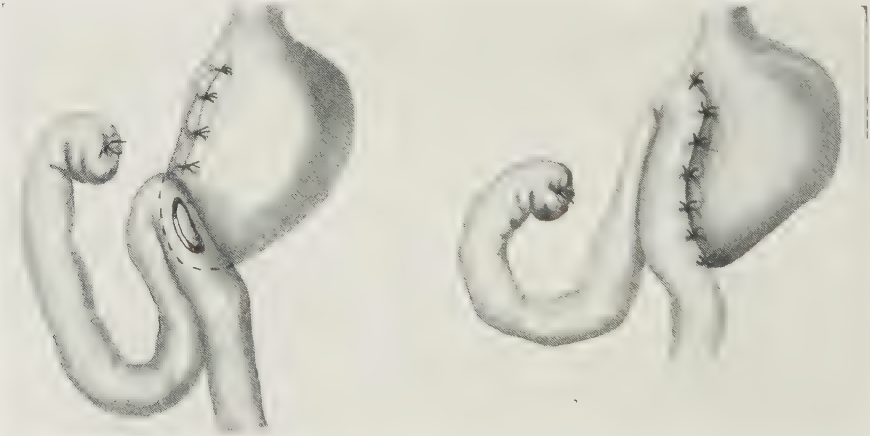


Fig. 3576.—The Same _ B–2; _ Essentially the same as the preceding, except that the jejunal loop-anastomosis is made with the anterior aspect of the stomach: **a,** The free, invaginated end of the duodenum; _ **b,** sutured end of the stomach left free after excising its pyloric portion; _ **c,** site of loop anastomosis of the jejunal loop with the anterior wall of the stomach; **d.** site of lateral jejunojejunostomy.



Figs. 3577 and 3578.—Pylorectomy for Gastric Carcinoma, Followed by Terminal Anastomosis of the Jejunal Loop to the End of the Sutured Stomach, Over a Greater or Less Part of Its Extent _ Alternate Technic of Billroth's Method II _ C–1: _ **a,** Anastomosing the jejunal loop with the lower end of the sutured walls of the stomach; _ **b,** anastomosing the jejunal loop with the entire divided end of the stomach. Any intermediate degree of the stomach end, between these extremes, may be utilized.

Pylorectomy, Followed by the Anastomosis of the Jejunal Loop to the End of the Sutured Stomach.—Alternate technic of Billroth Method II (Figs. 3577 and 3578) _ Here, too, the excision of the pyloric end of the stomach is accomplished as described in the body of this article (p. 363) _ after which the excess of the stomach opening is closed by suture (Fig. 3579), exactly as described in the Billroth Method I _ and into the lower part, left open, the antimesenteric aspect of a loop of the upper jejunum is anastomosed. A loop of jejunum as near the duodenojejunal junction as possible is chosen _ and this is drawn through an opening made in an avascular part of the transverse mesocolon. The completed operation is shown in Fig. 3580.

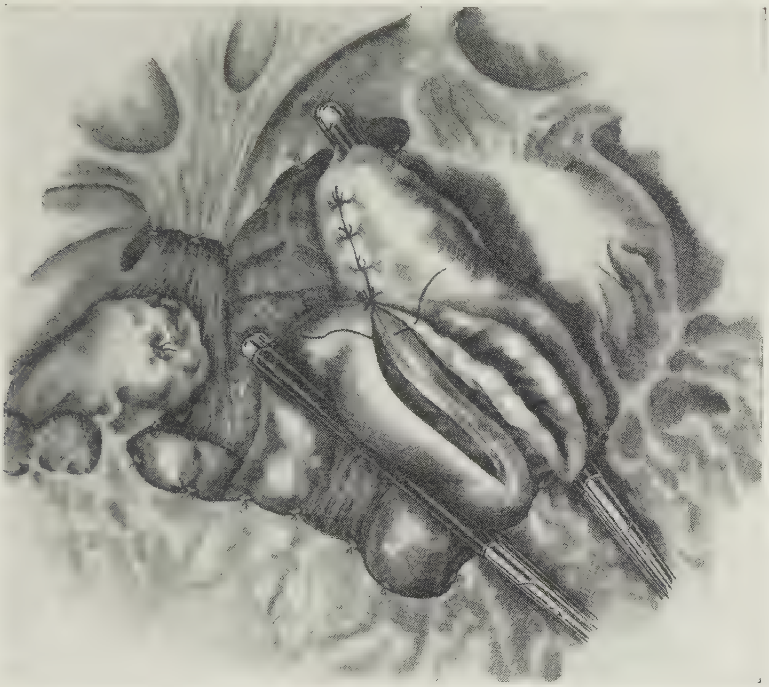


Fig. 3579.—The Same _ C–2; _ The preliminary steps to the actual anastomosis do not differ, materially, from those of the preceding technics. The jejunal loop is being here anastomosed with the lower half or three-quarters of the sutured end of the stomach. The end of the duodenum has been closed by invagination. The stomach and the jejunal loop are both clamped. The upper portion of the stomach end has been closed by suture _ and the incised loop of jejunum is being doubly sutured to the margin of the lower portion of the still open stomach end. A marginal stitch is shown in this last union _ the previously placed posterior seromuscular stitch is not shown.

In both of the above alternate methods, as, indeed, in all methods, great care is taken to completely close in, by suture, all openings made in the gastrohepatic and gastrocolic omenta, and in the transverse mesocolon _ which may have been necessitated by the necessary manipulations of the operation _ so that there will remain no chance for hernia through them of any of the neighboring viscera.

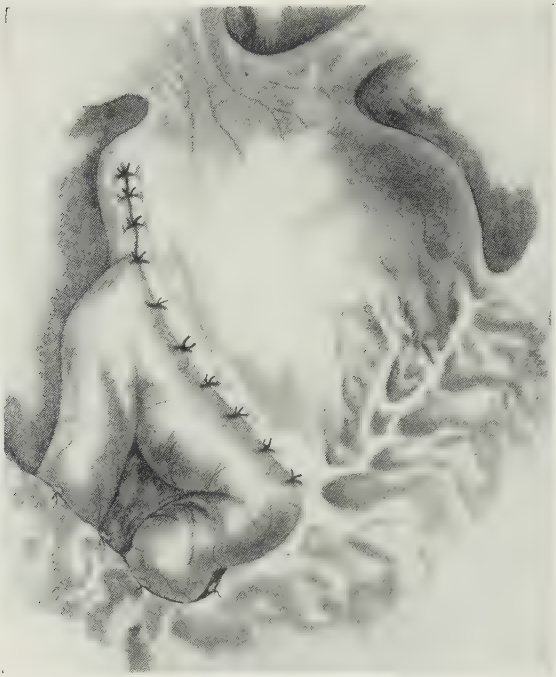


Fig. 3580.—The Same ‗ C–3; ‗ The completed operation.

PYLORECTOMY, FOLLOWED BY POSTERIOR GASTROJEJUNOSTOMY, BY THE LOOP-TO-END METHOD

MAYO'S TECHNIC

Description.—The operation consists of the excision of more or less of the pyloric end of the stomach ‗ followed by the closure of the proximal end of the duodenum, and the making of posterior gastrojejunostomy by the loop-to-end method. The operation is, practically, a partial gastrectomy ‗ and is resorted to for malignant disease of the gastroduodenum. The writings of William J. Mayo will be here largely followed. (See Comments.)

Incision.—Preliminarily, a limited incision is made in the median line, midway between the ensiform cartilage and umbilicus, for exploration ‗ and nothing more is done if the case be inoperable ‗ the abdomen being closed. Otherwise this incision is enlarged to the extent of 10 to 12.5 cm. (4–5 inches).

Operation.—Having opened the abdomen, the liver is retracted upward, the stomach depressed, and the structures in the neighborhood of the pylorus and duodenum exposed. The four arteries which supply the gastroduodenum are controlled early in the operation, so as to minimize the hemorrhage. The gastric is doubly ligated and divided about 2.5 cm. (1 inch) below the cardiac orifice, where it passes to the lesser curvature. The gastrohepatic omentum is doubly ligated and divided as far as necessary (from the site of ligation of the gastric artery to the structures in the free border of the omentum), the division being made close to the liver and leaving the greater portion of the structure adherent to the stomach. The lesser peritoneal cavity is thus opened up and the pyloric end of the stomach mobilized, together with the tumor. The entire region is well protected with gauze packing.

The pyloric artery is now doubly tied and divided near the pylorus _ and the first part of the duodenum freed for 3 or 4 cm. ($1\frac{1}{4}$ or $1\frac{1}{2}$ inches) preparatory to its later resection. Having entered the lesser omental cavity, and guided by a finger beneath the pylorus, raise the gastrocolic omentum from the transverse mesocolon and thus safely ligate the right gastro-epiploic artery (or its parent vessel, the gastroduodenal). Thence doubly ligate and divide, progressively, the gastrocolic omentum distal to the lymphatic glands and vessels, up to the indicated point on the greater curvature, where the left gastro-epiploic vessels are ligated. In ligating off the omenta the line of ligatures should be so placed that the lymph-nodes will be left with the part of the gastroduodenum to come away. Avoid tying or cutting the middle colic artery in entering the lesser omental cavity by separating it from the mesocolon _ as it is generally the entire supply of the transverse colon. The duodenum is divided by actual cautery between two clamps, leaving a stump 3 mm. ($\frac{1}{4}$ inch) _ through the end of which a running catgut suture is placed before the clamp is removed, and drawn tight as the clamp comes away (Fig. 3581). This stump is then inverted by a silk or linen seromuscular purse-string suture placed around the duodenal stump, 2 cm. ($\frac{3}{4}$ inch) below its end.

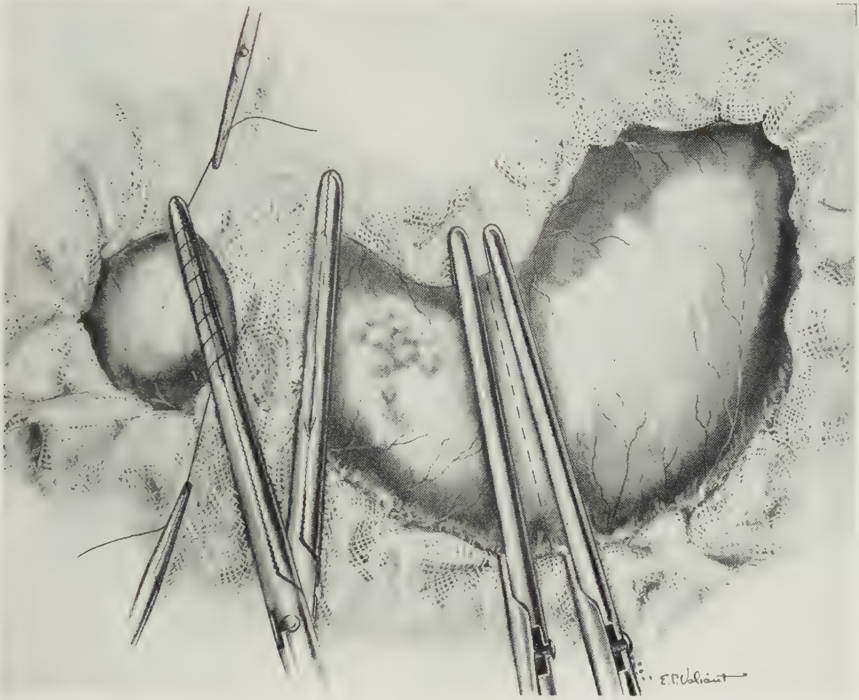


Fig. 3581.—Pylorectomy, Followed by Posterior Gastrojejunostomy, by the Loop-to-end Method _ Mayo's Technic _ I; _ The duodenum has been divided between double clamps by actual cautery. The free end of the duodenum has been whipped, over the clamp, by a through-and-through continuous suture, which will be tightened upon relaxation of the clamp, after which it will be invaginated within the duodenum by seromuscular Lemberts. The stomach likewise is being divided, between double clamps, by cautery.

A stomach-clamp, guarded with rubber tubing, clamps the stomach from the ligated gastric artery at Mikulicz's point of election, obliquely to Hartmann's point of election at the greater curvature, or along any indicated line.

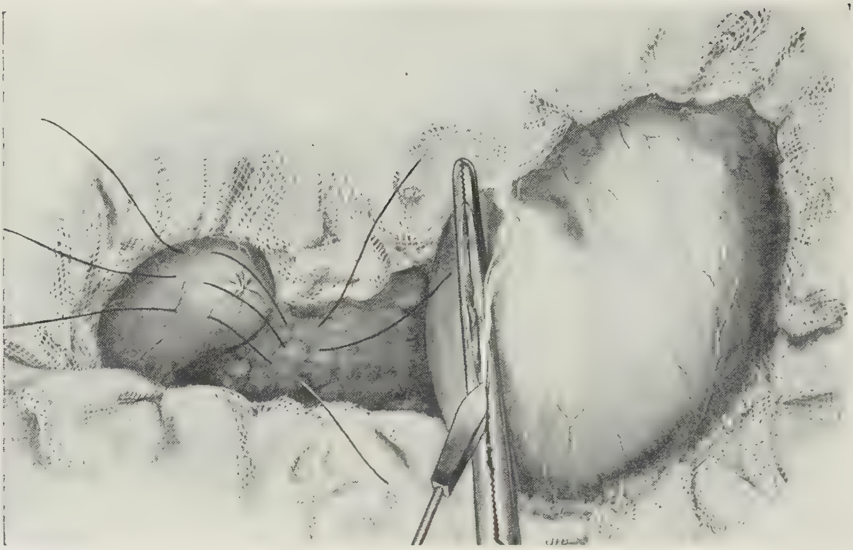


Fig. 3582.—The Same – II; – The end of the duodenum has been invaginated, and is being anchored by sutures to the head of the pancreas. The cut margins of the stomach are being further sterilized by actual cautery to prevent carcinomatous dissemination.

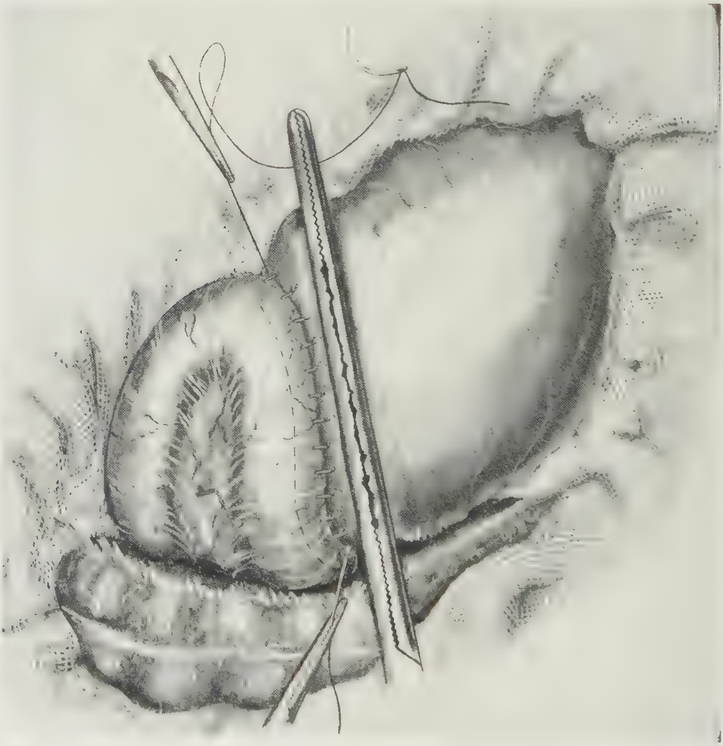


Fig. 3583.—The Same – III; – The clamped end of the stomach is drawn forward, while the posterior, seromuscular suture is attaching the coil of jejunum to the posterior wall of the stomach, near to and parallel with the line of section. The line of incision into the duodenum (shown by dotted line) will be as long as the length of the stomach opening.

A second stomach-clamp is applied to the pyloric aspect of the first clamp, to guard against leakage at the time of division. The stomach is now divided through both of its walls by means of the actual cautery 3 mm. (¼ inch) from the holding clamp (Fig. 3582) _ the severed part of the cardiac end being caught, as divided by catch forceps, to prevent retraction within the bite of the forceps. The pyloric end of the stomach, with the tumor, is now removed.

An incision is made in the transverse mesocolon and a loop of the jejunum drawn through, and a portion of it convenient for approximation to the opened end of the stomach, and as near as possible to the duodenojejunal junction is chosen. This is so clamped as to present a length of its antimesenteric aspect long enough to correspond with the stomach opening. While the original stomach-clamp is in position the loop of jejunum is applied to the stomach wall immediately posterior to the clamped margin _ and the posterior layer of the seromuscular suture applied (Fig. 3583) The original stomach-clamp is then removed, and the stomach is grasped by a rubber-covered holding clamp (such as is also used upon the jejunal loop) _ which is placed somewhat nearer the cardiac end of the stomach (the posterior blade passing behind the posterior layer of the seromuscular suture line). The lumen of the stomach between this clamp and the free margin of the stomach is thus opened up (and its fluid contents caught upon gauze) _ and is approximated to the

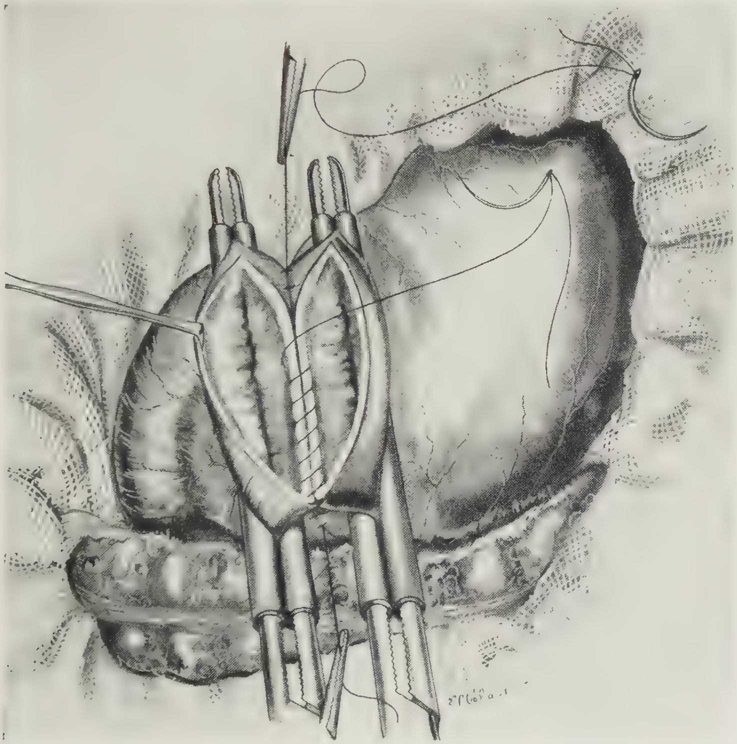


Fig. 3584.—The Same _ IV; _ The crushing clamp upon the stomach has been removed and rubber-covered holding clamps have been applied to both the jejunal loop and stomach _ the posterior blade of the stomach-clamp now passing behind the posterior seromuscular suture of anastomosis. The free margins of jejunum and stomach are being sutured together _ after which the seromuscular stitch will be continued on around the anterior aspect of the stomach opening.

coil of the jejunum, whose antimesenteric aspect is now incised _ so that the lumina of jejunum and stomach are brought into contact (Fig. 3583). The free margins of jejunum and stomach are then sutured together by a through-and-through chromic catgut stitch. When this has been carried around the entire circumference, the posterior layer of the seromuscular stitch is carried around the anterior aspect of the opening _ thus completing the anastomosis.

After the loop-to-end gastrojejunostomy has been accomplished, all of the anastomosed portion of the stomach is pulled down until it comes to lie below the opening in the transverse mesocolon _ after which the margins of the mesocolic opening are sutured to the wall of the stomach (Fig. 3585). The abdomen is closed as usual.

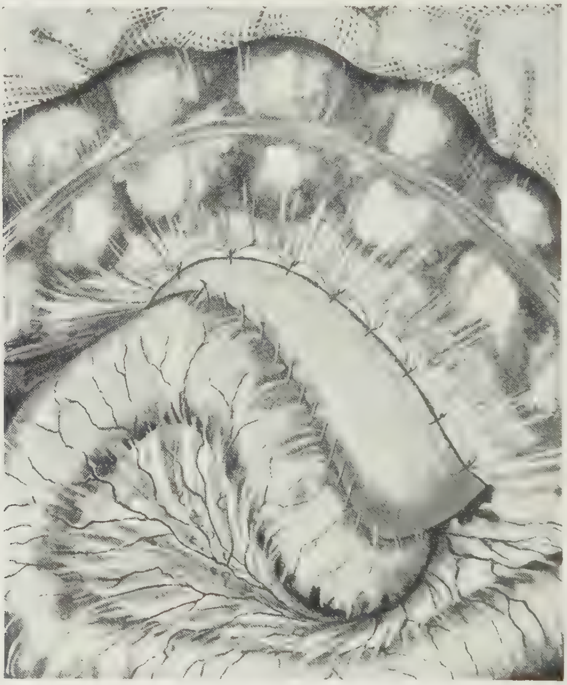


Fig. 3585.—The Same _ V; _ The completed loop-to-end gastrojejunostomy. The anastomosed portion of the stomach has been drawn down below the incision in the transverse mesocolon _ the margins of which have been sutured to the wall of the stomach.

After-treatment.—The patient's head and shoulders are raised by four or five pillows. Rectal alimentation is used. After twelve hours hot water is given by mouth in ½-ounce doses, increased to 1 ounce every hour. After thirty-six hours careful feeding with fluid food is used.

Comment.—Stress is laid upon the division of viscera and omenta with the actual cautery _ as means of avoiding the dissemination of cancer cells throughout the abdomen. Careful gauze packing is used throughout _ a deeper layer, which is not changed from beginning to end of operation, to further aid in preventing dissemination _ and a superficial layer, which is being constantly changed. Cigarette drains are used when much soiling has occurred, the drain coming from just above the transverse colon and emerging at the lower angle of the wound.

The loop of jejunum drawn through the slit in the transverse mesocolon must be long enough to allow of approximation without too much tension.

In the event of disparity of fit, between the incision in the loop of jejunum and in the stomach opening, Mayo writes, _ "If the diameter of the end of the stomach be very large it can easily be diminished by placing the sutures in such manner as to take a proportionately greater bite in the stomach than in the intestine, thus reducing the lumen of the stomach as the suturing progresses."

Chromic catgut is employed for the through-and-through sutures _ and fine silk or linen for the seromuscular suturing.

The anastomosis is termed a posterior gastrojejunostomy, not in the sense that the jejunum is anastomosed with the posterior aspect of the stomach, but because the loop of jejunum has been brought through the opening made in the transverse mesocolon, into the lesser peritoneal cavity, although the completed anastomosis is again drawn through and below the mesocolic opening. The loop of jejunum is really anastomosed, terminally, with the new end of the stomach, equally with the anterior and posterior gastric lips.

PYLORECTOMY, FOLLOWED BY AN INDEPENDENT END-TO-SIDE POSTERIOR GASTRO-DUODENOSTOMY

KOCHER'S TECHNIC

Description.—This procedure consists in the excision of the pylorus, with as much of the adjacent stomach and duodenum as indicated _ followed by the complete closure, by suture and invagination, of the pyloric end of the stomach _ and the anastomosis of the cut end of the duodenum to the posterior aspect of the stomach, near to its excised end.

The operation has been quite successful in the hands of its deviser _ but, in common with all forms of gastroduodenostomy following partial excisions of the stomach, it frequently shares the difficulty of bridging the gap and bringing the end of the duodenum into easy contact with the stomach. The duodenum must be freely mobilized in order that the anastomosis may be made without too great tension _ and where this cannot be accomplished, some other type of operation should be adopted. Where the part to be removed is small, leaving a correspondingly narrow gap, and where, at the same time, the duodenum can be sufficiently mobilized, the technic may be applied _ but, altogether, is not generally considered as desirable as one of the forms of pylorectomy followed by gastrojejunostomy.

Incision.—About 10 to 15 cm. (4–6 inches) in length _ beginning a short distance below the ensiform cartilage, and extending as far as necessary below the umbilicus, in the median line.

Operation.—Perform ordinary median abdominal section _ excise the umbilicus _ control hemorrhage _ retract the lips of the wound. Mobilize and bring into the wound the involved parts, lifting them as far out of the abdominal cavity as possible (Fig. 3586). Ligate off the lesser and greater omenta for an extent corresponding to the area involved and sever them with scissors from the stomach and duodenum, near the visceral borders, including the glands. Ligate all bleeding vessels with gut. Isolate the parts from which the omenta have been separated _ and protect, with gauze packing, the underlying and adjacent parts from the stomach and intestinal contents. A clamp is placed upon the duodenum just distal to the part to be removed _ and a second clamp about 2.5 cm. (1 inch) still distal to the first, and parallel with it, the handles of the clamps lying in opposite directions. Two clamps are now placed across the pyloric end of the stomach, in the same line, on the cardiac side of the growth – one being placed from the lesser and one from the greater curvatures, their ends overlapping.

The duodenum is now cut through between its two clamps – the edges of the distal end being disinfected with 1 : 1000 bichlorid, and turned over the right edge of the wound – and the proximal end wrapped in gauze and lifted out of the wound. An Assistant, using his forefingers and thumbs (or first and second fingers) as a second pair of clamps, seizes the stomach from above and below, a short distance to the cardiac side of the stomach-clamps – and compresses the stomach firmly, gauze being placed to catch any leakage from the stomach. The stomach is now cut through between the two stomach-clamps – and the growth removed – and all bleeding vessels ligated with gut.

The cut edges of the stomach are now first sutured with continuous silk, or, preferably, catgut suture, passing through all three coats in an overhand, or whipping fashion – approximating the anterior and posterior walls.

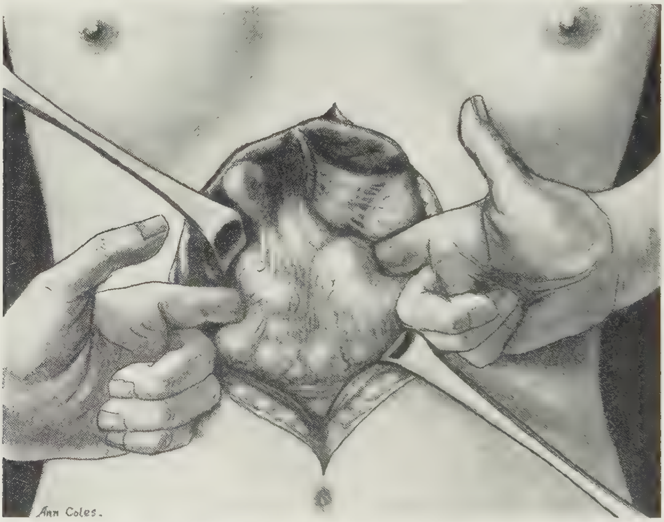


Fig. 3586.—Pylorectomy, Followed by an Independent End-to-side Posterior Gastroduodenostomy – Kocher's Technic – I; – Mobilization of the pyloric end of the stomach and upper part of the duodenum preparatively to accomplishing end-to-side gastroduodenostomy. The index-fingers are elevating the pyloric end of the stomach and the second part of the duodenum, from behind, on either side of the duodenal flexure and its anchoring hepatoduodenal ligament.

All projecting mucous membrane is disinfected with bichlorid. This line of primary suturing is then invaginated by a second line of continuous silk Lembert sutures of serous and muscular coats – thus burying in the first line and extending a short distance beyond its ends. The Assistant, holding the stomach in both hands, so manipulates it as to direct its posterior wall to the front and to the right, compressing the duodenum between the stomach and right edge of the abdominal wound and thus closing the lumen of the gut.

While the stomach is thus held the posterior aspect of the duodenum (still in the grasp of the forceps) is applied to the posterior wall of the stomach (the serous surfaces of both being in contact – Fig. 3587). A continuous posterior seromuscular suture of silk is now placed between the serous and muscular coasts of the posterior wall of the stomach and the posterior aspect of the duodenum thus approximated, from the upper to the lower border of the intestine – both ends of the suture being left long after knotting, and the needle threaded to the lower one. These sutures in the intestine are placed sufficiently far from its extreme end to leave the circumference of the extreme end of the gut free for suturing to the stomach opening. The hitherto retained forceps are unclamped from the duodenum _ (unless a pair should be kept on further down) _ and whatever leakage occurs is caught upon gauze _ the lumen of the gut is then cleansed _ and the vessels are gut ligatured. The posterior stomach wall is now incised vertically about 1.2 cm. ($\frac{1}{4}$ inch) from the posterior serous suture just inserted, and for a distance equal to the breadth of the duodenum. Bleeding vessels are gut ligatured. A continuous gut ligature is now passed, upon curved needle in holder, uniting the edges of the cut end of the duodenum to the edges of the stomach opening, passing through all the coats of both viscera, around the entire circumference. This line of suturing is chiefly for strength. If preferred, two rows may be used _ one of the mucous membrane _ and one of the serous and muscular coats. Taking up, next, the still threaded end of the posterior seromuscular suture, that line of continuous suturing is continued around the anterior aspect, forming the anterior seromuscular suture, passing through the serous and muscular coats of the intestine and stomach, until the surfaces throughout the entire circumference are approximated, and is then tied to the opposite free end of the suture.

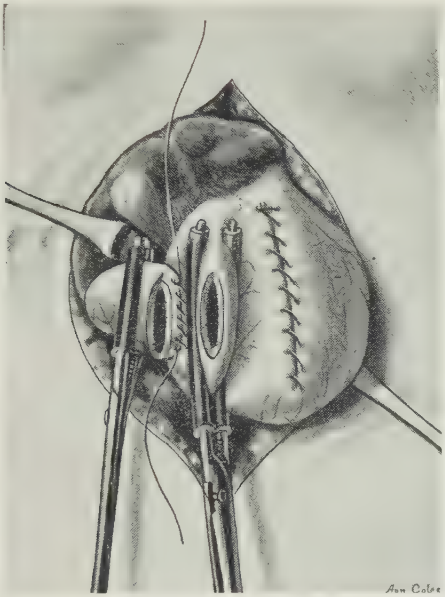


Fig. 3587.—The Same _ II; _ The pyloric end of the stomach has been excised, and the free end closed by a double line of sutures. The cardiac aspect of the stomach is then brought forward and turned somewhat to the left, while the free end of the mobilized duodenum is being anastomosed with the vertically incised opening in the posterior wall of the stomach, near its closed end, by a double tier of sutures. The posterior layer of the seromuscular suture has been placed, and the posterior layer of the through-and-through marginal suture will follow _ after which each will be continued around the anterior aspect of the gastroduodenostomy opening.

The parts are then thoroughly cleaned and disinfected and dropped back into place. Prior to the return of the parts to the abdomen the free edges of the lesser and greater omenta should be gut ligatured to the upper and lower margins, respectively, of stomach and intestine at the site of operation. The abdominal wound is then closed as in ordinary median abdominal section.

Comment.—(**1**) The omenta can be ligated off conveniently with Cleveland's ligature-carrier or an aneurysm needle. (**2**) The division of the stomach and intestines is usually made with scissors. (**3**) A rather long abdominal wound may be needed to enable sufficient lateral displacement to the right to expose the gastroduodenal site sufficiently for the necessary technic upon the accuracy of the details of which so much depends. (**4**) While the Murphy button may be used for approximation after the excision of the growth Kocher advises against it, as being mechanically less reliable. (**5**) A second pair of stomach-clamps may be employed instead of the fingers of an Assistant.

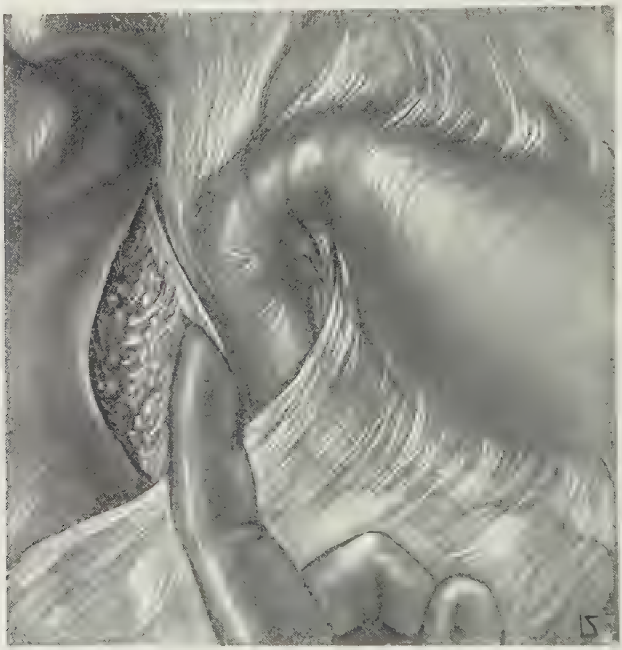


Fig. 3588.—Mobilization of the First and Second Portion of the Duodenum – Kocher's Technic; – The pylorus and first portion of the duodenum are partially mobilized by a superficial incision of the anterior portion of the right aspect of the lesser omentum. The second portion of the duodenum is rendered movable by a somewhat vertical division of the peritoneum (about 1.2 cm., ½ inch, outside of the intestine), parallel with and just to its right over the right kidney, – after which the duodenum can be displaced mediad, by the finger, for apposition with the stomach.

(**6**) The cut portions of the tissue upon the part of the duodenum and stomach retained, are first cleansed, and then disinfected with lysol and alcohol. (**7**) The mobility of the duodenum should be assured early in the operation, as the free mobilization of this structure is essential to the operation. Having mobilized the lower border of the first portion of the duodenum, hugging the intestine and doing no unneeded damage to its blood-supply, the peritoneal fold attached to its upper border is severed near to the gut, and its vessels doubly ligated. The Surgeon next passes a forefinger posterior to the first part of the duodenum, in order to ascertain both whether its division will be through healthy tissue, and also whether it is sufficiently free to enable it to be sutured to the posterior wall of the stomach without too much tension. If it be shown that it will not easily reach to the stomach, it can be further freed by incising the peritoneum over the right kidney, at the distance of about 1.2 cm. (½ inch) outside of its second portion – and then detaching this second part inward toward the stomach, as shown in Fig. 3588.

PARTIAL GASTRECTOMY OF THE MEDIAN PORTION, FOLLOWED BY GASTROGASTROSTOMY

Description.—The median portion of the stomach is chiefly excised for hour-glass stricture from ulcer, and occasionally for malignancy. The free edges of the remaining portions are then united end to end. Any excess in size, upon the part of the cardiac end, is provided for by special suturing. (See Comments.)

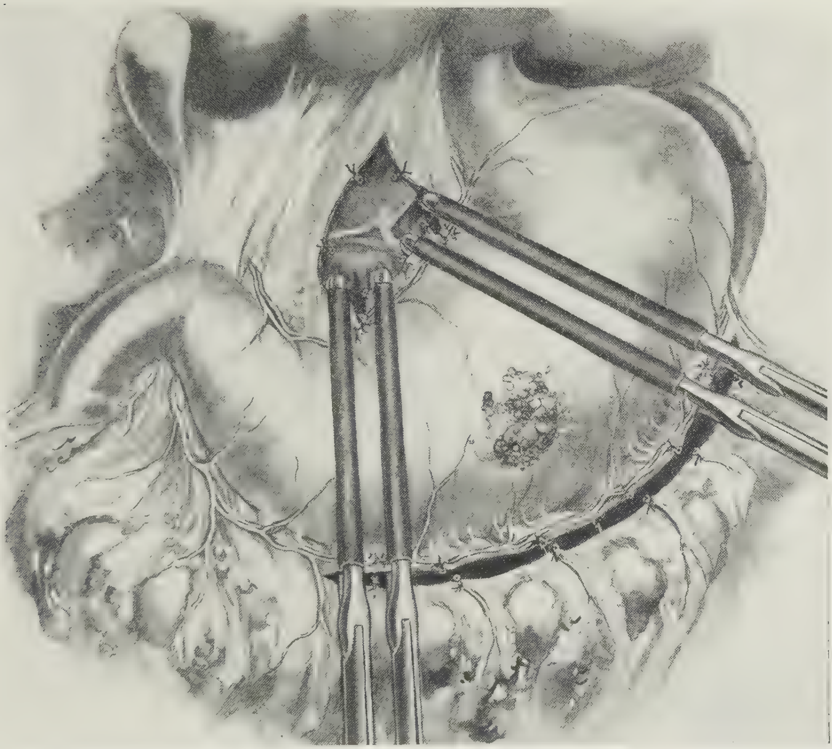


Fig. 3589.—PARTIAL GASTRECTOMY OF THE MEDIAN PORTION – I; – The cardiac and pyloric aspects of the stomach are doubly clamped, ready to be divided. The gastrohepatic and gastrocolic omenta are ligated and divided. The arteries of the lesser and greater curvatures are doubly ligated and divided.

Preparation – Position – Landmarks – Incision.—As for the exposure of the stomach by median incision.

Operation.—The stomach is brought into the field. The arteries along the upper and lower curvatures of the stomach are ligated (Fig. 3589) – the gastric artery along the lesser and the epiploic arteries along the greater curvature – so planning the double ligatures as to leave satisfactory blood-supply to the remaining borders. The gastrohepatic and gastrocolic omenta are ligated off in sections, corresponding with the portion of the stomach to be excised, after which the lesser peritoneal cavity and the adjacent parts are protected with gauze packing. Double clamps are now placed on each side of the area to be excised, about 2.5 cm. (1 inch) apart, and allowing ample margin of healthy tissue between the growth and themselves. The involved portion of stomach is now cut away with scissors passing through all the coats and traveling between each set of clamps _ especial care being used to guard the field from the inevitable leak that occurs on entering the mucous cavity of the organ. The free edges of the incised portions are now approximated by means of the clamps, and held in a convenient position for suturing (Fig. 3590). A posterior layer of seromuscular suturing is first placed _ then a marginal through-and-through suture of chromic catgut is carried completely around the opening _ and, finally, the anterior layer of the seromuscular suture is completed. Where the calibers of the two portions are about alike, no great difficulty is experienced in adjusting them to each other.

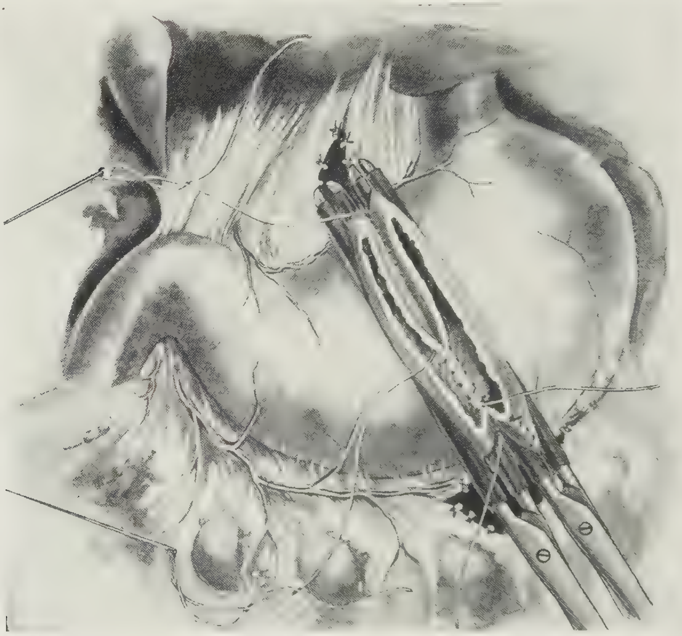


Fig. 3590.—The Same _ II; _ The median excised portion of the stomach has been removed, and the incised edges of the cardiac and pyloric aspects are approximated by means of clamps. The posteriia layer of the seromuscular suture has been placed _ its free end showing. The posterior layer of the through-and-through suture has also been placed _ and one end left free. The redundant portion of the cardmc portion of the cardiac aspect of the stomach is sutured separately by through-and-through and serous-or cular sutures until its caliber corresponds with that of the pyloric aspect.

Where a disparity of circumference exists _ the cardiac end usually being larger than the pyloric end, the margins of the larger side are first brought together far enough to leave a remaining circumference corresponding in size with that of the opposite side.

The omental incisions are sutured with catgut _ no openings being left for possible hernia.

Comments.—Excision of the median portion of the stomach, followed by gastrogastrostomy, is chiefly applicable to cases of benign growths. Moynihan holds that in all cases of malignancv the entire lesser curvature should be removed.

If the pyloric and cardiac aspects of the stomach cannot be readily brought together after the excision, mobilization of the duodenum will usually enable this to be accomplished. There should be no tension whatever upon the sutures uniting the two halves.

CARDIECTOMY, FOLLOWED BY GASTRO-ESOPHAGOSTOMY

MARWEDEL-BIER TECHNIC

Description.—No systematic technic has been worked out for the excision of the cardiac end of the stomach, with re-establishment of the esophago-gastro-intestinal tract _ as may be called for sometimes in cancer and in ulcer. The operation is performed at considerable depth and the technical difficulties are great _ and, in the comparatively few cases in which the procedure has been carried out, individual technics, as to details, have been executed. And, too, since the improvements in intrathoracic surgery conducted under differential pressure methods the cardiac end of the stomach has also been approached by the transthoracic route (v. p. 70).

In the operation here given, of excision by the abdominal route, the Marwedel method of approach will be described, and the Bier method of dealing with the involved parts. Also see Operations for Gastric Cancer, in General, p. 354 _ and Comments, p. 384.

Exposure (Marwedel).—A firm, round cushion is placed under the patient's back, so that the patient's body is rounded forward in the neighborhood of the costal arch, thereby increasing to the utmost the space between diaphragm and cardia. The incision begins at the ensiform process, and runs parallel with the left costal arch, and about 2.5 cm. (1 inch) below it, ending at the tip of the left tenth costal cartilage. It is everyhwere carried through the abdominal wall, into the peritoneal cavity. The interval is sought between the anterior lying rectus and external oblique muscles, severed from the costal arch by the incision, and the posterior lying internal oblique and transversalis muscles attached to the ribs. The portions of the rectus and external oblique severed from the costal arch are drawn, by a broad retractor, upward and to the left (Fig. 3591). By this retraction the cartilages of the seventh, eighth, and ninth ribs are exposed. The seventh costal cartilage is divided close to the sternum _ and the seventh, eighth, and ninth costal cartilages are severed, posteriorly, just in front of their ribs. The chondromuscular flap thus freed is then displaced and retracted upward and to the left, hinging on the internal intercostal muscle and anterior intercostal membrane between the sixth and seventh cartilages _ and safeguarding the pleura from injury during the section of the cartilages (especially the seventh) and displacement of the composite flap. In this way good view and access to the left hypochondrium are secured. The technic of exposure is very similar to that of the Baudet-Nevarro operation (Figs. 3450 and 3451).

Excision of the Cardia and Union of the Proximal End of the Divided Esophagus With the Anterior Wall of the Sutured Pyloric End of the Stomach (Bier).—In the case upon which Bier applied this method a carcinoma had involved the upper part of the lesser curvature and the cardia. Its removal, by excision, was accomplished without especial difficulty _ and the anastomosis between the divided esophagus and the remaining portion of the stomach was carried out without mobilizing the lower part of the thoracic esophagus. It is to be remarked, however, that the peritoneally covered intra-abdominal esophagus was rather long in this case. The involved part of the stomach and its cardiac portion were everywhere freed from their adhesions. The stomach was then doubly clamped and divided _ between the pylorus and the tumor. The pyloric end of the stomach was then closed by suture (presumably by a through-and-through marginal suture of chromic catgut, followed by a seromuscular suture of silk or linen). The clamped cardiac end of the stomach was left, temporarily, in continuity with the esophagus, handle-fashion, as it were, _ for the purpose of making the manipulation of the esophagus easier during the anastomosis. The pyloric end of the stomach, has been closed by suture, is again seized by clamps near the suture line (if not still in the grasp of them), to also aid in the manipulation of this part.

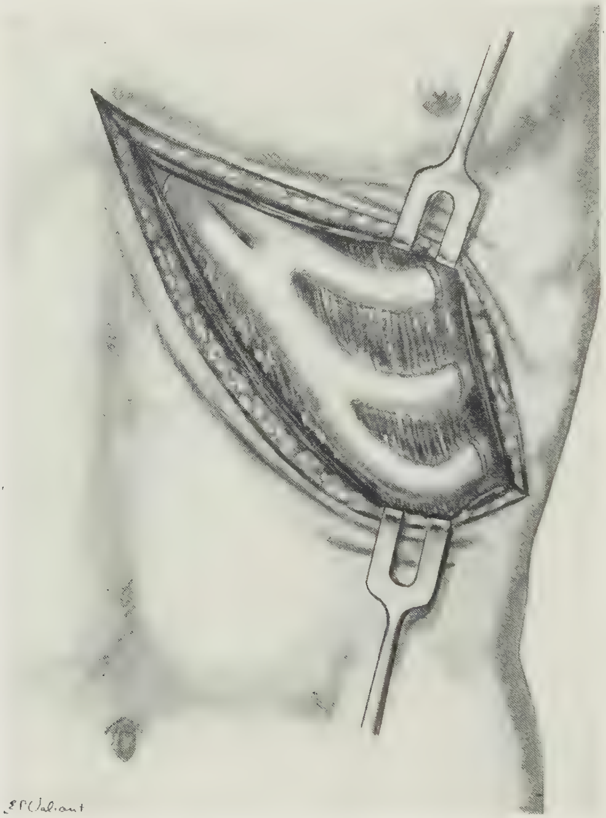


Fig. 3591.—Cardiectomy, or the Excision of the Cardiac Portion of the Stomach _ Marwedel's Method of Exposure _ I; _ Raising the chondromuscular flap. For details of this step, see text, p. 381.

Note _ The second step of this operation is so similar to the Baudet-Navarro technic (q. v.) that it will not be separately pictured. In it the chondroplastic flap is displaced upward and to the left, exposing the left hypochondrium, with the esophagus, left lobe of the liver, and gastrocolic omentum shown in the field.

An anastomosis is now made between the end of the esophagus and the anterior wall of the remaining part of the stomach (Fig. 3592). An incision is made through the anterior wall of the pyloric stomach, parallel with its sutured margin, corresponding in length with the diameter of the esophagus. The posterior wall (only) of the clamp-closed esophagus is cut through, at first. The serosa of this posterior wall of the esophagus, above its transverse incision, is sutured, by seromuscular suture of silk, or linen, to the serosa of that lip of the incision made into the pyloric stomach which is nearer the sutured margin. A marginal suture of chromic catgut is then carried through all the coats of the posterior lips. This line of suturing anchors the esophagus – so that the section through its posterior wall is now continued around its anterior wall – after which the cardiac portion of the stomach and its tumor are removed from the field. The marginal suture of the posterior margins is now continued through all the coats of the anterior lips – and, finally, the posterior seromuscular suture is carried around the anterior aspect of the wound, completing the anastomosis. The lesser and greater omenta which have been divided in the earlier part of the operation are repaired and anchored so that no gaps for hernia are left. The abdomen is then closed, with or without temporary drainage, as may be indicated.

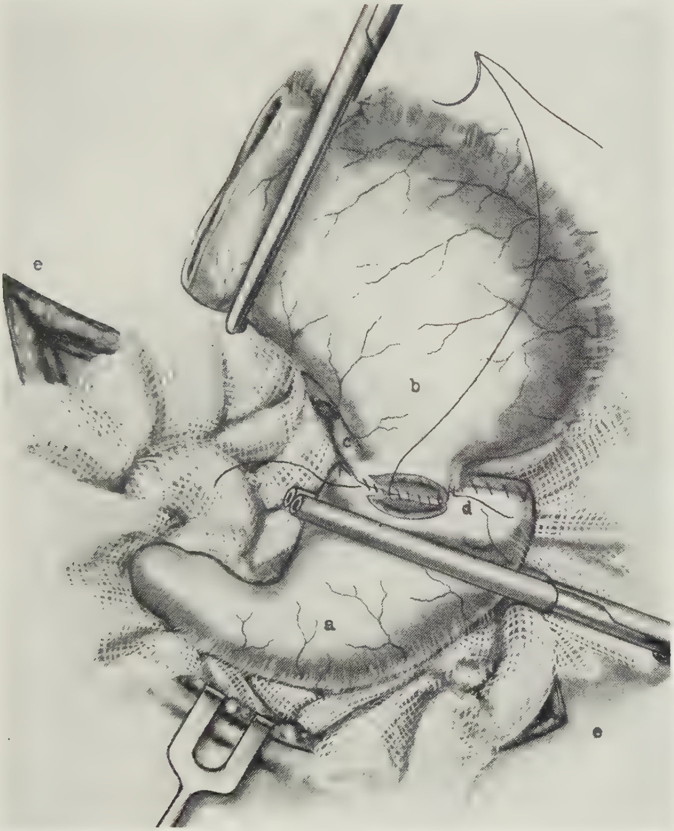


Fig. 3592.—The Same – II: – **e**, **e**, The wound of exposure; – **a**, pyloric aspect of the stomach, with the line of its transverse division, sutured; – **b**, cardiac aspect of the stomach, which has been severed from the pyloric portion – and which, manipulated by the clamp which closes its divided end, serves as a convenient handle, as it were, during the suturing of the esophagus, **c**. The posterior tier of seromuscular and of the marginal sutures are seen at **d**. For further explantation see text.

A most unusual accident marred the case in which Bier applied the above technic. In the manipulations during operation, a piece of the carcinomatous mass broke off, and, undetected, passed up the esophagus into the mouth – whence it was aspirated through the larynx. An immediate low tracheotomy was done, and a piece of the tumor the size of a walnut was removed from the trachea and bronchi. The patient, however, only survived nine hours _ and at postmortem a piece of the tumor was found to have blocked the left bronchus. The details of the anastomosis were found entirely satisfactory.

Comments.—The abdominal part of the esophagus is from 2 to 3 cm. ($\frac{13}{16}$–$1\frac{3}{16}$ inch) long _ posteriorly lie the diaphragmatic crura _ anteriorly, the esophageal sulcus of the liver _ the left inferior phrenic artery runs behind the esophagus to the diaphragm _ and the right phrenic nerve lies behind, and the left phrenic nerve in front of the esophagus.

By careful mobilization of the esophagus at the diaphragmatic opening the available esophagus can sometimes be considerably lengthened _ up to as much as 7 cm. ($2\frac{3}{4}$ inches) in the total. The abdominal portion of the esophagus is covered with peritoneum, and if union can be made with this part of the tube, the chances for satisfactory union are correspondingly increased.

Kocher advises a double row of silk sutures. No tension upon the suture line must be allowed _ and if union cannot be brought about without tension, some other method of procedure must be adopted.

The Murphy button has been used in some cases _ but can only be employed where the esophageal end is covered with peritoneum.

The esophagus itself may be cancerously involved _ adding greatly to the difficulty of the problem. The associated glands may be difficult to remove.

Effort should, of course, be made to preserve the pneumogastric nerves _ but it has happened that either one or both have been cut. Their sacrifice is not incompatible with the safety of the patient.

To avoid the division of intercostal nerves necessitated by the Marwedel incision of approach, Mikulicz's incision may be employed. Starting at the ensiform cartilage, it runs downward in the median line, to just above the navel _ turning, thence, to the tip of the left tenth rib, and dividing the left rectus muscle. A second incision is made over the left eighth rib below the left breast _ and through this the seventh, eighth, and ninth ribs are divided, avoiding injuring the pleura.

TOTAL GASTRECTOMY, FOLLOWED BY GASTROJEJUNOSTOMY

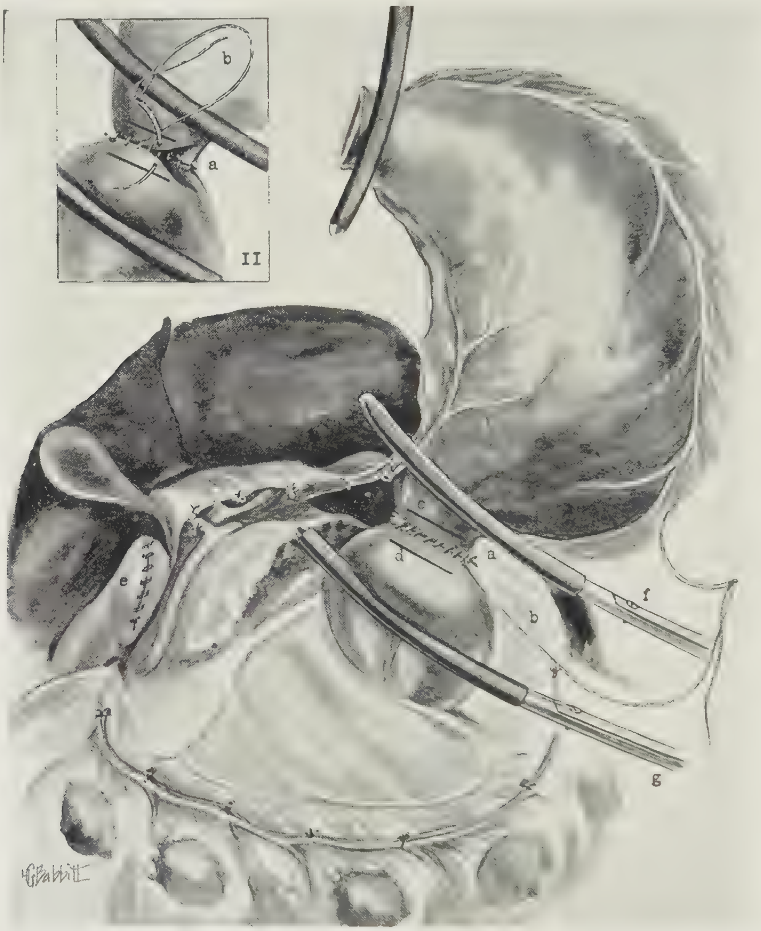
MOYNIHAN'S TECHNIC

Description.—The stomach has now been removed a number of times successfully. Flechtenmacher has collected 36 cases of total gastrectomy in all. In the majority of instances the jejunum was united with the esophagus, following the removal of the stomach. In some cases the anastomosis was made between the esophagus and the duodenum _ which, of course, is more physiologic, but which frequently cannot be safely accomplished without too much tension, if at all, because of the distance which has to be spanned, even after reasonable mobilization of the duodenum. Patients seem to accommodate themselves very comfortably to the absence of their stomachs _ some dilatation of the tract usually serving the rôle of food-receptacle.

Operation.—The description of the technic Moynihan employed is as follows: _ The abdomen was entered by a median abdominal section, the incision at first being about 3 inches in length _ which was, later in the operation, increased to 8 inches _ much difficulty having been experienced in exposing the stomach, which was small, with thick walls and generally invaded the growth, and with a minimum cavity. The case seemed so unfavorable that, at one time total gastrectomy, with the performance of duodenostomy or jejunostomy, was contemplated as the only alternative measures possible. But as the operation progressed, it seemed possible to accomplish more satisfactory results.

The coronary artery was divided, between two clips, at its origin from the celiac axis – the proximal end being ligated. The superior and inferior groups of coronary glands were removed by blunt dissection and gauze-stripping, working downward toward the stomach – and the cardiac end of the stomach was similarly denuded. The gastrohepatic omentum was ligated and then divided as near to the liver as possible – and the upper border of the pylorus exposed. The pyloric and gastroduodenal arteries were here exposed at their origin from the hepatic trunk by blunt dissection and gauze-stripping. Having ligated the pyloric artery, a finger was passed down posterior to the pylorus and under it – when, opposite the end of the finger, an opening was made in the gastrocolic omentum and the blade of a clamp was passed through this opening and guided up behind the duodenum – until it protruded above the pylorus, after which the blades were clamped about 2.5 cm. (1 inch) beyond the pylorus – with the subpyloric group of glands lying on the stomach side of the clamp. A second pair of clamps, rubber-covered, were applied distally to the first pair – and the duodenum divided between them. The distal end of the duodenum was first closed by a through-and-through layer of catgut, and this was turned in by a double layer of Pagenstecher thread. The clamp upon the proximal end of the duodenum was additionally secured by a suture passed through the part and tied around the clamp, and the clamp and duodenum protected by gauze wrapping. The proximal end of the duodenum was displaced to the left, so bringing the gastroduodenal artery into the field that it could be doubly tied and ligated. The gastrohepatic omentum was ligated and divided at a distance of from 1 to 2 inches (2.5–5 cm.), along the entire greater curvature, leaving the glands with the sacrificed stomach. Thus the whole stomach was freed from all attachments including the gastrosplenic and gastrophrenic omenta, except for its continuity with the esophagus. By having the Anesthetist bend the patient's head slightly forward, a little additional length of esophagus was made available at the diaphragmatic opening, through the practice of careful traction – securing about $\frac{3}{4}$ inch (1.9 cm.) in the total.

The anastomosis of esophagus and jejunum is now undertaken. A loop of the upper jejunum, about 8 inches from the duodenojejunal junction, is drawn through an incision in the transverse mesocolon. A portion of this jejunal loop, of about $2\frac{1}{2}$ inches (6.2 cm.), is laid transversely immediately behind the esophagus (Fig. 3593, I. In this position the right leaf of the mesocolon was posterior, and the proximal end of the jejunal loop was to the patient's left, and the distal end of the jejunal loop to the right. The esophagus was rendered prominent and accessible by the upward traction of the still connected stomach, which served, throughout the anastomosis, as an admirable handle. Eight interrupted seromuscular sutures are introduced, uniting the surface of the jejunum which is now posterior, $\frac{3}{4}$ inch from its mesenteric attachment, with the surface of the esophagus which is posterior in the normal condition of the parts (but is anterior when the esophagus is drawn forward and upward). The esophagus is made to present itself prominently during the suturing by upward and outward traction. It is the control over the esophagus exercised by the still attached stomach that constitutes a large feature of the technic – making rather easy an anastomosis which would otherwise prove most difficult. Directly in front of these eight most posterior interrupted sutures, another line of continuous seromuscular suturing is carried – exactly as in gastro-enterostomy, leaving the ends of the suture long, and one end threaded (Fig. 3593, II). Thus the site of anastomosis has two tiers of sutures upon its posterior aspect, holding esophagus and jejunum together. Beginning in front of the (patient's) extreme left of this continuous suture, a small incision is made, parallel with the suture line, into both the esophagus and the jejunum. With a fresh needle and Pagenstecher, a continuous through-and-through stitch unites the posterior margins of the small length of the double incision _ Fig. 3595 _ after which the small incisions in



Figs. 3593 and 3594.—Total Gastrectomy, Followed by Gastrojejunostomy _ Moynihan's Technic _ I and II; _ The stomach has been everywhere freed, except from the esophagus, and is henceforth used as a handle, or tractor, for manipulating the esophagus during the performance of the anastomosis. A loop of jejunum has been drawn through an incision in the transverse mesocolon _ and, while held in contact with the upwardly stretched esophagus, its posterior aspect is sutured to the posterior aspect of the esophagus by several interrupted, anchoring stitches of the serosa and muscularis (II, **a**). The line of the gastro-esophageal section, as well as the lines of esophageal and duodenal anastomosis, are shown at **c** and **d**. The second one of the three posterior tiers of sutures is the continuous suture, **b**, seen in both I and II. In II the first, or interrupted line of sutures, is hidden by the second, or continuous line.

esophagus and jejunum are slightly increased _ and their posterior lips similarly sutured _ and this rotation of cutting ond suturing is continued until the entire posterior part of the esophagus is divided and sutured to the corresponding incision in the jejunum. And the same line of suturing is continued around the anterior lips of the two incisions (Fig. 3596). The anterior stitch may be

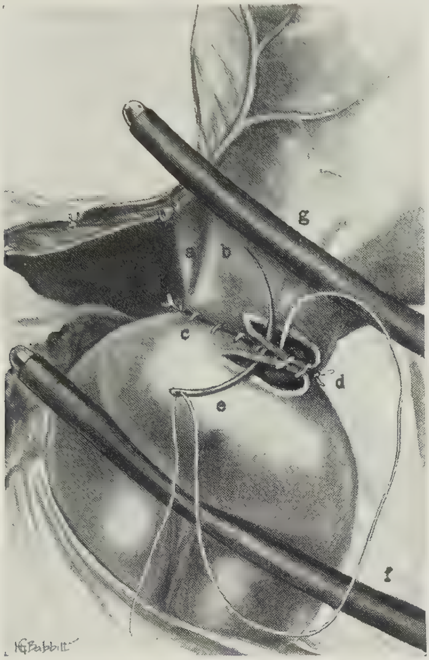


Fig. 3595.—The Same _ III; _ The third, or marginal tier of the posterior suturings _ the cutting and suturing progressing in turns: _ **a**, Esophagus _ **b**, gastric aspect of the gastro-esophageal zone _ **g**, clamped stomach _ **f**, clamped jejunal loops. The first line of posterior interrupted sutures is indicated by one of the knots, at **d**; _ **c**, second line of posterior continuous suturing; _**e**, third line of posterior marginal suturing.

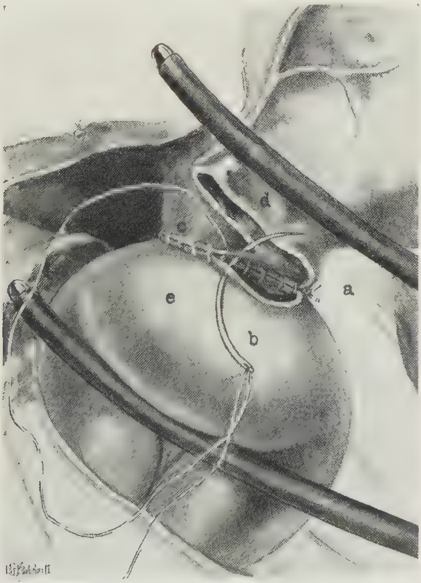


Fig. 3596.—The Same _ IV; _ The first, or marginal tier of the two anterior lines of suturing: _ **d**, Cardiac end of stomach, in the act of being finally divided and simultaneously sutured; _ **e**, jejunal loop; _ **a**, third or marginal tier of posterior suturing; _ **c**, **b**, first tier of anterior marginal suturing.

changed to the "loop on the mucosa" type (v. p. 323, Fig. 3541). Thus the stomach is kept as a tractor, by which the esophagus is pulled down until the last portion of it is divided – and, by that time, the line of anastomosis is practically finished. Finally, the outer continuous seromuscular suture which was temporarily put aside upon completion of the posterior layer of seromuscular suturing, is again taken up and continued around the anterior aspect of the anastomosis, and tied. To summarize, there are eight posterior interrupted anchor-sutures, one seromuscular marginal suture around the lips of the two openings; and one reinforcing seromuscular suture around the site of anastomosis. To these are added a few anterior anchor-sutures to secure the esophagus and jejunum to the diaphragm. The great omentum is then turned up over the field of operation – and the abdomen closed.

The patient, following operation, was given 9 pints of normal saline fluid by rectum in the first twenty-four hours – and 6 in the second twenty-four hours. On the third day 2 teaspoonfuls of water were given every half hour by mouth – 2 ounces every hour, on the fifth day (alternating water, albumen-water, and peptonized milk). These were gradually increased – until 5 pints of the same fluid were being taken on the tenth day. On the eleventh day, beef-tea and Benger's food were given – on the fourteenth day, milk-pudding – and, on the eighteenth day, dry bread and butter. At the end of the third week he began eating increasingly. During the first days following operation the chin is held forward to prevent tension upon the site of anastomosis.

CHAPTER LXVII

OPERATIONS UPON THE PANCREAS

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Desjardin's partial pancreatoduodenectomy, followed by gastrojejunostomy, choledochojejunostomy, and pancreatojejunostomy, p. 415.

SURGICAL ANATOMY

Description.—The pancreas lies transversely across the posterior abdominal wall, the large vessels intervening between it and the wall _ being on a level with the second lumbar vertebra (and sometimes with the first or third) _ lying in the epigastric and left hypochondriac regions _ having the stomach in front, duodenum to the right, and spleen to the left _ and the aorta, vena cava, celiac plexus, thoracic duct, and diaphragmatic crura behind. It lies behind the posterior wall of the lesser omental cavity and is between the laminæ of the mesocolon of the transverse colon. The head of the pancreas is surrounded by the loop of the duodenum. The tail of the pancreas is in contact with the interno-inferior aspect of the spleen. Peritoneum covers the pancreas except upon its posterior surface. The viscus is 15 to 16 cm. (about 6 inches) in length – 3 to 4 cm. ($1\frac{1}{4}$–$1\frac{1}{2}$ inches) in width – and 15 to 18 mm. (about $\frac{1}{2}$ inch) in thickness.

Relations.—Anteriorly; Upper layer of transverse mesocolon; lesser peritoneal sac; transverse colon; gastroduodenal and pancreaticoduodenal arteries; stomach (posterior surface). **Posteriorly**; second (sometimes third or first) lumbar vertebra; crura of diaphragm; aorta and right and left renal arteries and superior mesenteric artery; inferior vena cava, superior and inferior mesenteric, splenic, and right and left renal veins; vena portæ; celiac plexus; thoracic duct (origin); ductus communis choledochus and pancreatic duct; left kidney (and sometimes its capsule). **Superiorly**; Duodenum (first part); liver; hepatic and splenic arteries and celiac axis; solar plexus. **Inferiorly**; Duodenum, third (preaortic) and fourth (ascending) parts; duodenojejunal angle; jejunum; transverse colon; transverse mesocolon (inferior layer); superior mesenteric artery and vein; inferior mesenteric vein; mesentery. **Right end**; Loop of duodenum. **Left end**; Interno-inferior aspect of spleen.

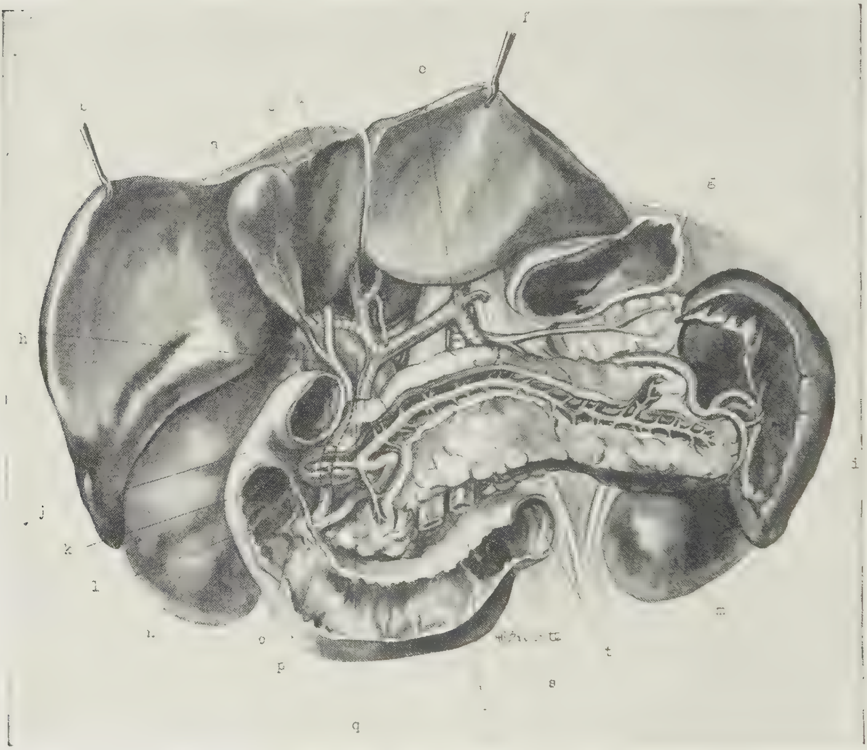


Fig. 3597.—Anatomic Structures of the Upper Abdomen: – **b**, Right hepatic lobe; – **a**, gall-bladder; – **c**, **d**, right and left branches of the hepatic artery; – **e**, celiac axis; – **f**, left hepatic lobe; – **g**, cardiac end of stomach; – **h**, common bile-duct, formed, from above, by the cystic and hepatic ducts; – **i**, spleen; – **j**, descending limb of the duodenum; – **k**, accessory pancreatic duct; – **l**, ductus choledochus; – **p**, pancreatic duct; – **o**, common duodenal opening of the ductus choledochus and pancreatic duct; – **n**, right kidney; – **q**, portal vein; – **r**, superior mesenteric artery and vein; – **s**, gastroduodenal artery; – **t**, pancreas; – **m**, left kidney. (Modified from various Anatomies.)

Fixations.—Held in place by its peritoneal investment and by adjacent viscera and structures to which attached.

Pancreatic Duct (**Canal of Wirsung**).—Begins at left end, or tail, of

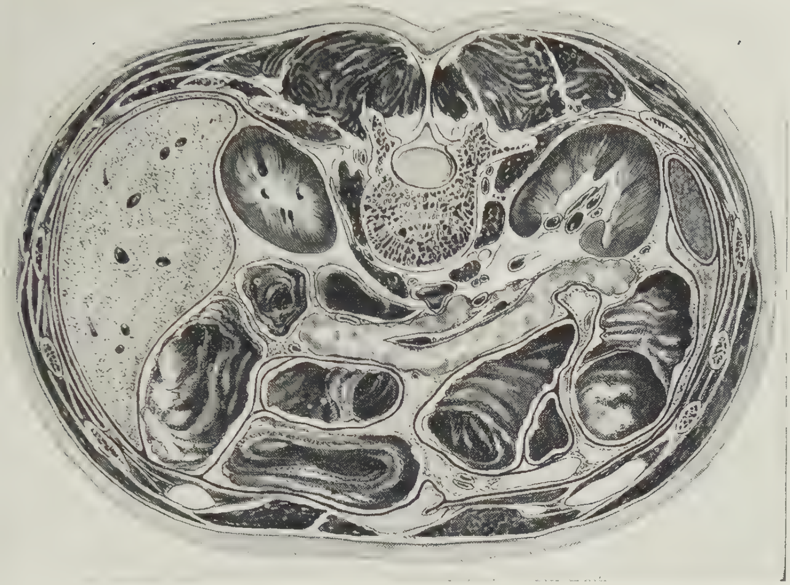
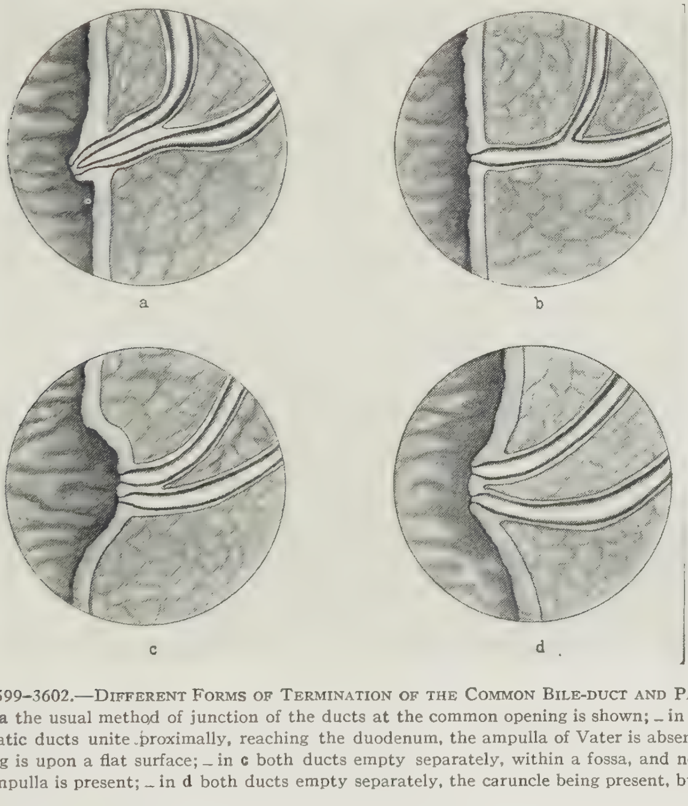


Fig 3598.—Transverse Section of the Body at the Level of the Pancreas. (Redrawn from Braune.)



Figs. 3599–3602.—Different Forms of Termination of the Common Bile-duct and Pancreatic Duct: _ In **a** the usual method of junction of the ducts at the common opening is shown; _ in **b** the bile- and pancreatic ducts unite proximally, reaching the duodenum, the ampulla of Vater is absent, and the duct opening is upon a flat surface; _ in **c** both ducts empty separately, within a fossa, and neither caruncle nor ampulla is present; _ in **d** both ducts empty separately, the caruncle being present, but the ampulla absent.

pancreas _ runs thence toward the head of the organ, passing nearer its posterior than anterior aspects _ after passing the neck, it turns downward, backward, and to right, in the head of the viscus, and runs to the left side of the common bile-duct _ entering the duodenal wall together and parallel with the ductus communis choledochus _ uniting with the latter while running obliquely in the walls of the duodenum _ and emptying by a common opening with it upon a papilla of mucous membrane about 10 cm. (4 inches) from the pylorus _ the opening being covered by a fold of mucous membrane from above. The pancreatic duct is recognized by its white color and its relation to the pancreatica magna artery. Its diameter, near its termination, is between 2 and 3 mm. (about $\frac{1}{9}$ inch). The Duct of the Lesser Pancreas (Duct of Santorini) may join the Canal of Wirsung near its termination _ or may empty into the duodenum by a separate mouth.

Arteries.—Pancreaticæ parvæ and pancreatica magna from splenic artery; pancreaticoduodenalis superior from gastroduodenalis of hepatic; pancreaticoduodenalis inferior from superior mesenteric.

Veins.—Accompany the above arteries, emptying into splenic and superior mesenteric veins.

Lympatics.—End in two glands upon superior mesenteric artery.

Nerves.—From solar plexus.

SURFACE FORM AND LANDMARKS

The pancreas lies obliquely behind the stomach _ crossing the spine opposite the second (or sometimes the first or third) lumbar vertebra. Anteriorly, it lies transversely about 7.5 cm. (3 inches) above the umbilicus.

There is no outward bodily contouring to suggest the position of the pancreas in normal conditions _ but there may be outward contourings of some of its pathologic conditions.

GENERAL SURGICAL CONSIDERATIONS IN OPERATIONS UPON THE PANCREAS

Operations upon the pancreas are now performed for a number of conditions _ as suggested by the headings of the following procedures in this chapter. Billroth successfully removed the pancreas, in 1884, for malignancy _ with recovery _ although rapidly fatal diabetes usually follows complete removal of the organ in man _ while complete removal, with subsequent life has been proved in animals.

Through surgical intervention in injuries, fat necrosis, resulting from escaping pancreatic secretion, has been prevented. And surgical intervention upon the biliary and intestinal tract has largely increased the scope of pancreatic surgery.

While the pancreas, owing to the nature of its almost enveloping surroundings, is generally well anchored, presenting a difficult surgical problem, yet its attachments are sometimes so lax that the organ can be delivered as a whole outside of the abdominal cavity (William J. Mayo). It has no anatomic capsule, but, under the influence of irritation, an adventitious capsule forms from the peritoneum and its derivatives.

The various routes of approach to the pancreas will be given under the exposure of the organ, pp. 394–399.

Pancreatic juice allowed to escape into the abdominal cavity is apt to excite peritonitis. Wounds of the pancreatic canals should be closed by suture _ and an outlying ligature should always be placed around, or through pancreatic tissue, before excising a portion of the organ – in order to prevent the escape of pancreatic juice.

If the pancreatic opening into the duodenum be cut off, either pathologically or surgically, a new route must be made, or a pancreatic fistula must be established.

Suturing material should not be left in contact with the pancreatic ducts, as such material may form the nuclei of calculi.

Excision of the tail of the pancreas, or of the tail and part of the body, or of limited portions of the head, present the simpler aspects of excision operations. The tail of the organ is the part most safely operated upon. In operating upon the head it is necessary to spare the canal of Wirsung or the duct of Santorini.

Koerte mentions a case of total pancreatectomy performed by F. Franke, in 1900, which recovered from the operation, but died five and a half months later in cachexia.

The chief dangers in operating upon the pancreas are from the escape of pancreatic secretion and from hemorrhage.

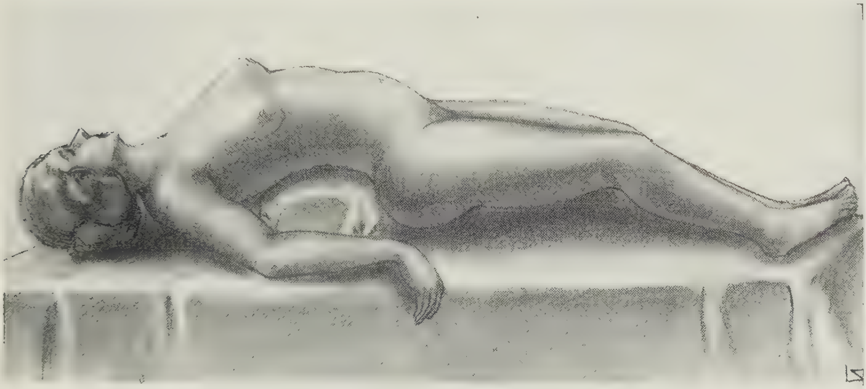


Fig. 3603.—Position of the Patient in Operating Upon the Liver, Pancreas, Spleen, and Stomach – when, by a support in the hollow of the back, the costal arches are elevated, thereby giving freer access to the subdiaphragmatic structures.

Coffey has shown that the pancreatic duct will re-establish itself, if ligated, within a few days by regeneration – in experimental work upon animals.

The escape of pancreatic juice takes place when the pancreas is surgically cut or traumatically injured, and the fluid thus thrown out causes, by the action of its ferments, fat necrosis where it comes into contact with fat tissue (as in the omentum, mesentery, and elsewhere) – active digestion of the tissues with which it comes into contact, including peritoneal adhesions which may have been formed for protection – and an irritative peritonitis (aseptic, or septic, dependent upon the presence of bacteria). The pancreatic fluid may also so act upon the blood with which it is in contact as to form excellent culture-media for bacteria. The only methods of meeting these serious conditions are careful suturing of damaged ducts with fine catgut – and equally careful closure of the peritoneum. If these measures cannot be satisfactorily brought about, free drainage should be established, so that the pancreatic fluid will find ready escape outward.

The occurrence of hemorrhage should be met by careful hemostasis, by fine catgut ligature, applied directly to the ends of the bleeding vessel if possible (which, unfortunately, usually is not possible). And if mass-ligature be applied, it is apt to cut through the frail tissue of the gland. If mass-ligature be used, it must be placed deeply _ and then the constriction which is made, even though moderate, is apt either to cut through and cause additional bleeding _ or to cause sloughing of the gland tissue. Absorbable material should be used in suturing and ligating.

For further general surgical considerations in operating upon the pancreas see Pancreatectomy, Partial and Complete, in General, p. 414.

METHODS OF EXPOSING THE PANCREAS

Several routes of reaching the pancreas are available _ and are as follows: _

(A) **Approaches from in Front:** _

(1) **Exposure of the Pancreas Above the Stomach, Through the Gastrohepatic Omentum _ by Median Abdominal Section Above the Umbilicus** (Figs. 3604, **c** and 3605, **a**).—The liver is retracted upward, and the stomach, downward _ after which the gastrohepatic omentum is incised above the stomach, and the bursa omentalis entered, when the pancreas is encountered, directly covered by the parietal peritoneum (and, the lesser sac intervening, by the reflection of peritoneum from the stomach to the liver) _ the middle portion of the pancreas projecting above the lesser curvature of the stomach. From this median incision, and also from a right-sided oblique incision (as employed in exposure of the gall-bladder) the head of the pancreas can be reached in the duodenal angle (Fig. 3606), where it is covered by the gastrocolic omentum (after the latter is cut through in a non-vascular space).

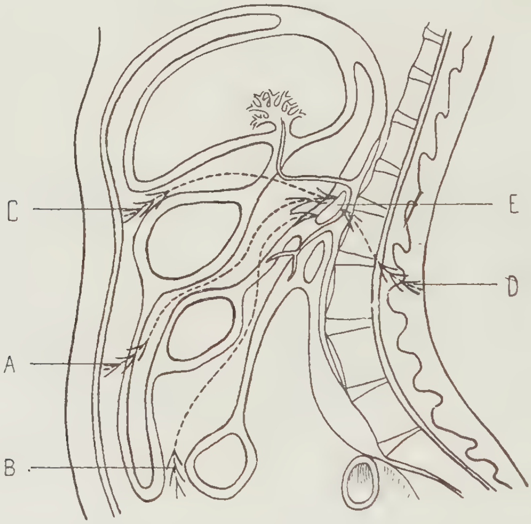


Fig. 3604.—Illustrating Routes of Approach to Pancreas: _ A, Gastrocolic; B, transmesocolic; C, transgastrohepatico-omental (epigastric); D, lumbar; E, pancreas. (Modified from Gray.)

The approach through the gastrohepatic omentum may be used when the pathologic condition presents above the lesser curvature, as less frequently happens.

(2) **Exposure of the Pancreas Below the Stomach Through the Anterior Layer of the Gastrocolic Omentum by Median Abdominal Section Above the Umbilicus** _ (Fig. 3604, A, and Fig. 3607).—The stomach is retracted upward, and the transverse colon downward _ after which the anterior

layer of the gastrocolic omentum is incised over the bursa omentalis, and immediately below the greater gastric curvature, when the lesser peritoneal cavity is entered, and the pancreas encountered upon its posterior wall, covered by peritoneum. This is the exposure of choice – and the one employed in the majority of surgical operations. The parts in this and in other exposures of the pancreas are brought more prominently and conveniently into the field if the patient, in the dorsal decubitus, have a firm support placed beneath the hollow of the back.

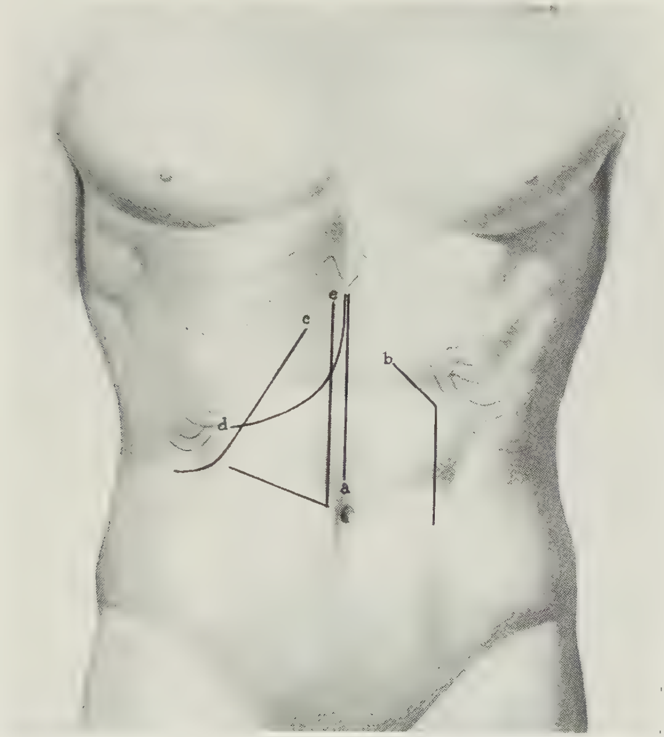


Fig. 3605.—Some of the More Usual Incisions for Exposing the Pancreas, Spleen, Liver, and Biliary Ducts: – A, Median incision for exposing the pancreas; – B, Bevan's, or Mayo's incision (with or without the angular extension inward) for the spleen; – C, oblique, paracostal incision, for the liver and bile-ducts; – D, D, Kehr's bow-shaped incision for the liver and biliary ducts; – E, Perthe's angular incision for the liver and bile-ducts.

(3) Exposure of the Pancreas Through the Transverse Mesocolon by Median Abdominal Section Above the Umbilicus (Figs. 3604, B and 3608).—The great omentum and transverse colon are displaced upward, and the small intestines to one side – after which the transverse mesocolon is incised in a non-vascular site, to the left of the vertebral column, over the left aspect of the pancreas. The large vessels and their branches must be carefully avoided, especially the superior mesenteric vessels, which run downward to the right in the mesocolon. The lesser sac is thus entered, and the anterior aspect of the pancreas exposed. Kroenlein names this as the most desirable route of approach to the pancreas – but is awkward if drainage must be employed. If only the inferior layer of the transverse mesocolon be incised, and its layers separated, access to the lower aspect of the pancreas is secured.

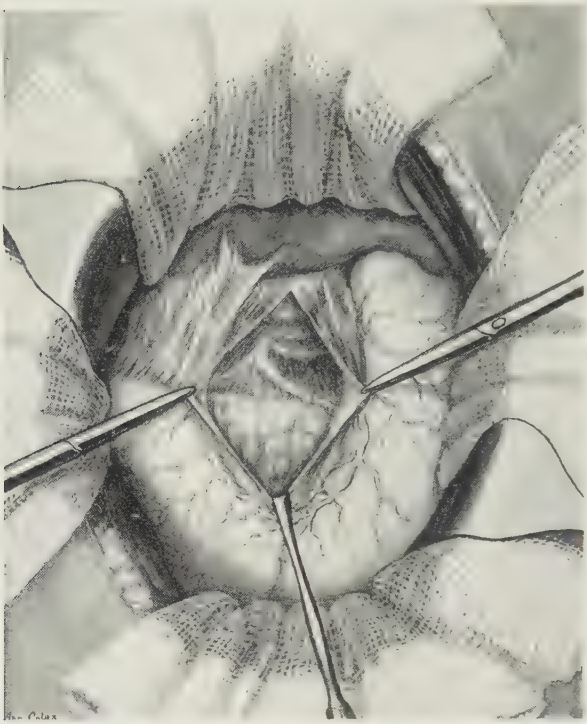


Fig. 3605a.—Exposure of the Body of the Pancreas Above the Stomach _ Through the Gastrohepatic Omentum; _ As detailed in the text.

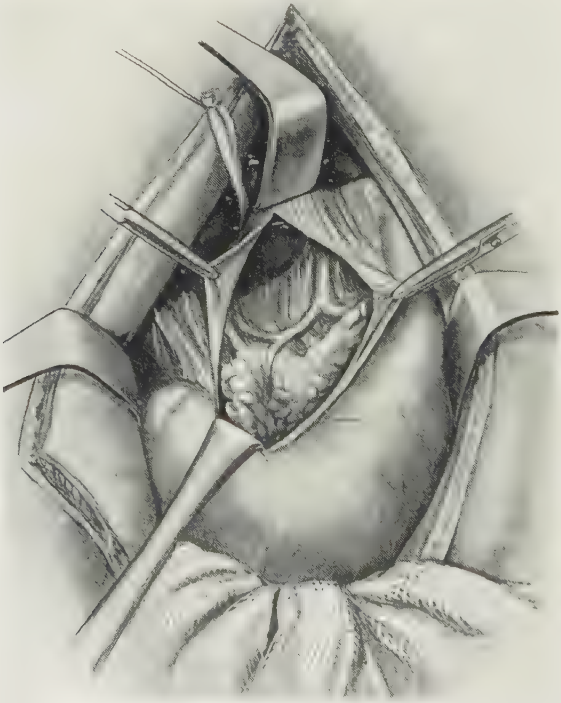


Fig. 3606 —Exposure of the Anterior Aspect of the Head of the Pancreas in the Horseshoe of the Duodenum After Incising the Gastrohepatic Omentum; _ As detailed in the text.

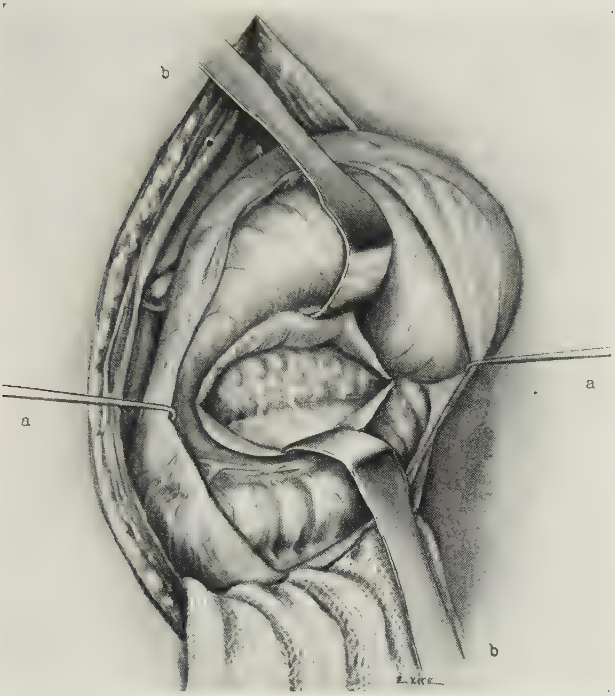


Fig. 3607.—Exposure of the Pancreas Below the Stomach Through the **Anterior Layer** of the Gastrocolic Omentum: – **a, a,** The stomach has been elevated, and the anterior **layer of the** gastrocolic omentum split from above downward, and retracted – after which the posterior **layer of the** gastrocolic omentum has been divided transversely, directly over the pancreas – and retracted, **b, b.**

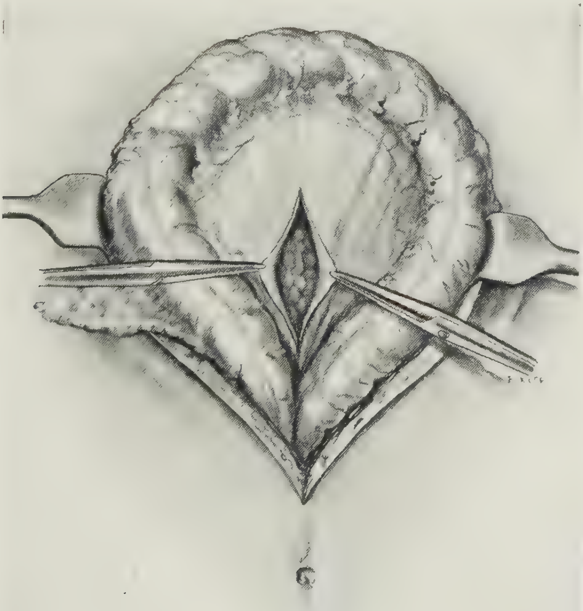


Fig. 3608.—Exposure of the Pancreas Through the Transverse Mesocolon; – **As detailed in the text.**

(B) Approaches from the Sides _ Intraperitoneally or Extraperitoneally: _

(1) Intraperitoneal Exposure of the Head of the Pancreas by Median Abdominal Section with Added Transverse Incision to the Right (Fig. 3609).—The liver and gall-bladder are retracted upward and to the right _ after which the peritoneum is incised to the right of the second portion of the duodenum, over the right kidney, when, by blunt dissection, the head of the pancreas can be freed and stripped upward, turning it over toward the median line _ so that its posterior aspect, as well as the ductus choledochus, are brought into the field of operation _ with the vena cava lying at the bottom of the wound.

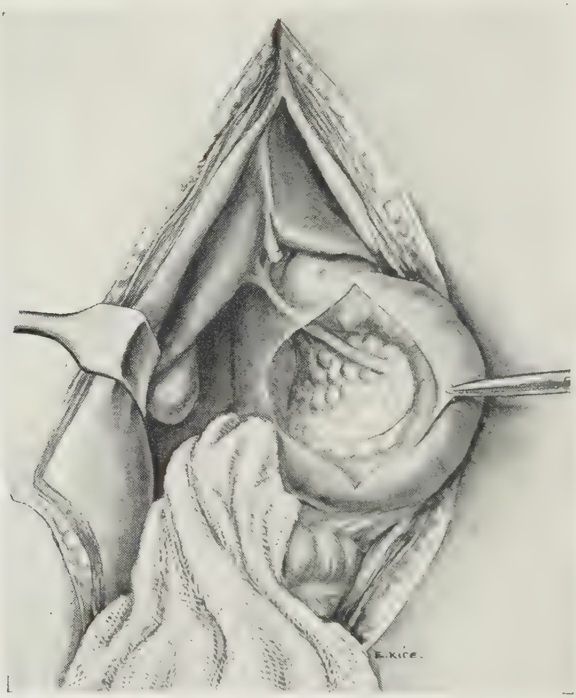


Fig. 3609.—Exposure of the Posterior Aspect of the Head of the Pancreas Through an Angular Incision; _ The duodenal horseshoe has been mobilized and turned forward.

(2) Extraperitoneal Exposure of the Head of the Pancreas by Right Lumbar Incision.—The posterior aspect of the head of the pancreas can also be exposed retroperitoneally through a right lumbar incision _ the peritoneum being freed, by blunt dissection, and pushed away, as the approach is made behind the second part of the duodenum and the head of the pancreas, over the anterior surface of the right kidney _ but the route is long and through a deep wound that affords unsatisfactory view and manipulation.

(3) Extraperitoneal Exposure of the Tail of the Pancreas by Left Lumbar Incision.—Having passed through the lumbar wall, the descending colon is bluntly dissected from its site and pushed toward the median line, working between it and the anterior surface of the left kidney _ until the left end of the pancreas is reached. This is also a deep and undesirable method of approach. It is sometimes used to evacuate retroperitoneal pus, which is usually on the left side.

(4) Intraperitoneal Exposure of the Tail of the Pancreas by Left Abdominal Section.—The transverse mesocolon is retracted upward and outward, and the posterior peritoneum incised over the outer aspect of the left kidney. Peters has exposed the tail of the pancreas by an incision extending from the tip of the left twelfth rib obliquely forward to the umbilicus.

Unusual Routes of Approach.—In a case of difficult adhesions Hagen operated upon a pancreatic cyst through both walls of the stomach. Where abscess has united pancreas and diaphragm, approach has been made transpleurally.

OPERATIVE TREATMENT OF WOUNDS OF THE PANCREAS

Owing to the unusually well protected position of the pancreas, it is rarely wounded _ and also owing to its close juxtaposition with other organs and structures it is rarely wounded alone _ so that its wounds are apt to be complicated with those of its neighbors.

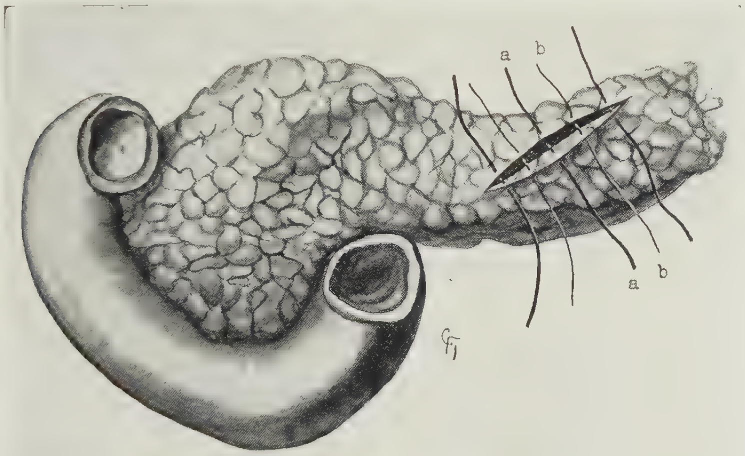


Fig. 3610.—Suturing an Incised Wound of the Pancreas; _ Alternate deep, **a**, and superficial, **b**, catgut stitches are seen, passing through the capsule and substance of the gland. In deep wounds of the viscus buried sutures may also be employed.

Wounds from sharp instruments and firearms, entering from without _ and lacerations, even to complete rupture, from violent outside contusions that do not break the skin _ are the traumatism most apt to be sustained.

No distinctive clinical phenomena lead to the definite conclusion that the pancreas has been wounded. Hemorrhage and promptly occurring peritonitis are frequent immediate sequences. The pancreas has been broken completely in two from a blow, leaving no external evidence of traumatism _ or a person may have a vehicle wheel pass over him, causing his own spine to cut his pancreas into halves, without the visible wounding of the skin.

Operation.—The abdomen is usually opened in the median line, between the xiphoid cartilage and the navel _ and the pancreas exposed through the gastrohepatic omentum, _ unless there be special contraindication to these routes, owing to the position of the wound. In exposing the organ, especial care is taken to prevent the free escape of the pancreatic fluid, along with the blood, into the peritoneal cavity _ because of its irritating and digesting effect upon the structures with which it comes into contact.

Incised wounds dividing but a part of the body are best sutured with rather thick catgut upon a curved needle _ some of the sutures passing deeply and some superficially as in Fig. 3610. Or the deeper parts of the wound may be sutured with heavier catgut, and the superficial part with fine catgut.

In Garré's case of complete transverse division of the spleen, by the buffers of cars which caught a man between them, the halves of the organs were successfully sutured together by three sutures of fine silk passing through capsule and parenchyma, posteriorly _ and three similarly placed, anteriorly _ somewhat after the manner shown in Fig. 3611. The wound was drained for about four weeks and the fistula was entirely healed in six weeks. To avoid the possibility of forming nuclei for calculi it would be better to use catgut in suturing.

In irregularly lacerated, or gunshot wounds, one may only be able to hold the parts into relatively close apposition by suturing _ depending upon the packing of the inner end of the gauze drain to control what hemorrhage such unsatisfactorily applied sutures do not control. Where the tissue of the gland is much disorganized by the traumatism, the best course may be to excise the damaged part _ as described under Partial Pancreatectomy, p. 415. Damage to the pancreatic duct by the Surgeon's procedure should be avoided.

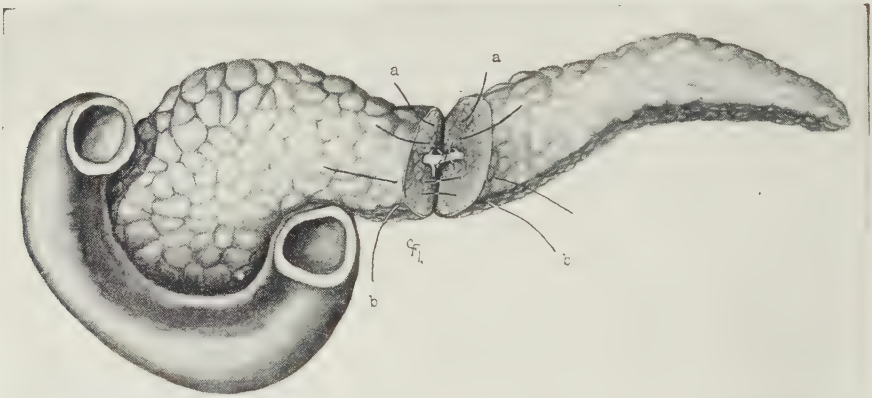


Fig. 3611.—Suturing the Completely Divided Pancreas and Its Duct: _ **a, a,** Sutures of catgut, passing through the posterior half of the organ and tied in the substance of the gland. The severed duct itself is carefully sutured with fine, non-penetrating catgut stitches _ the details of this suturing being almost too fine for demonstration, in the above drawing. **b, b,** Sutures passing through the anterior half of the organ and tied upon its anterior surface.

Access is sometimes better gained through the gastrocolic omentum.

It may sometimes be necessary to clamp a bleeding site with long-handled hemostats, which are then left on for twenty-four to forty-eight hours, coming out of the wound along with the gauze drain and packing.

If the pancreatic duct be wounded, an attempt should be made to expose and suture the lips of the wound together with fine catgut, which pass into the wall but not into the lumen of the duct (Fig. 3611) _ and, if this cannot be done, to suture the pancreatic tissue around the wounded duct.

Punctured wounds are usually repaired with one or two sutures.

Ligature *en masse* may be the only available means of controlling a general ooze from some special site.

Provision must be made, in closing the operation, to prevent the flow of pancreatic fluid from the wound into the peritoneal cavity _ and this is often so difficult to accomplish by the simple suturing of the parts of the wounded pancreas together, and reinforcing this by the suturing of the peritoneum forming the posterior boundary of the lesser sac, over the gland, that it practically amounts to laying it down as a rule, that almost all pancreatic wounds should be drained, at least temporarily _ by gauze in a glass tube, or split rubber tube, as a *conduit.*

Drainage is brought either out of the anterior wound of approach _ or a counteropening is made in the costovertebral angle for the exit of the drain _ and the anterior wound closed. Or drains may be brought out of both wounds.

Some of the results of the wounds of the pancreas are the following: _ Cyst formation within the pancreas _ conversion of the lesser sac into a cyst by closure of the foramen of Winslow _ pancreatitis _ abscess formation _ fat necrosis in the tract of the escaping pancreatic fluid _ prolapse or hernia of the pancreas _ and fistula.

PANCREATOTOMY AND DRAINAGE FOR ACUTE PANCREATITIS BY THE TRANS-GASTRO-HEPATIC OMENTAL ROUTE

Description.—Acute pancreatitis is an involvement of extreme gravity, often characterized, among other manifestations, by acute inflammatory changes, hemorrhage within and outside of the gland, and suppuration. These conditions may occur variously combined _ inflammation, hemorrhage, gangrene, suppuration. Hemorrhagic apoplexy has been considered a condition of acute aseptic pancreatic hemorrhage, in contradistinction to the same condition associated with sepsis. In addition, the escaping pancreatic ferments, from the portion of pancreas involved, cause fat necrosis, and peripancreatic peritonitis _ and, when bacteria are added, suppuration. The condition may be fulminating _ and, whether so or not, may prove one of the most unmanageable surgical problems, with unusually high mortality. Besides, the diagnosis may be difficult or impossible _ the usually sudden pain generally indicating a localized peritonitis in the region of the pancreas. The majority of patients die independently of operation.

The surgical indication is immediate abdominal section, with drainage of the site of lesion. The abdomen is sometimes opened simply as an exploration _ to discover by accident, as it were, an acute pancreatitis.

Incision of Exposure.—In those instances where there is a tumor-like prominence, as a result of the pathologic process, the incision is usually placed directly over it _ which will generally be either directly in the median line, between ensiform cartilage and umbilicus, or very near to it. It will sometimes happen that even after opening the abdomen by an anterior route, it will be wiser to drain by a posterior route _ in which case some modification of lumbar incision is added for drainage, and the anterior section closed.

Operation.—Having opened the abdomen, the further steps of the operation will largely depend upon the investigation of the pancreas and surroundings. The route by which the pancreas itself is to be brought into the field will be mainly determined by the locality of the pancreatic process. If the drainage is to be anterior, it goes without saying that approach through the gastrohepatic omentum will subserve that purpose best _ although it must observe, as well, the purpose of approach and manipulation. In the present instance it will be supposed that the process is most accessible through the gastrohepatic omentum.

On first opening the peritoneal cavity it may be concluded that acute pancreatitis is present if hemorrhagic fluid escape, and if the omentum present in the wound, showing areas of fat necrosis. The pancreas is at once examined by palpation through the gastrohepatic omentum, and is usually found enlarged, soft, and discolored. The gall-bladder tract, duodenum, and stomach are likewise examined. Steps are then taken to relieve the tension within the pancreas, and provide for outward drainage. Having retracted the liver upward, and the stomach downward, the gastrohepatic omentum is opened by blunt dissection and the pancreas brought into the field. When this is accomplished, and the surrounding region packed off as well as possible, several knife-point punctures or limited incisions are made into the glandular tissue, so that the outflow of blood and fluid thereby accomplished will afford relief, reducing the tension and furnishing free drainage _ which constitute the chief operative indications.

Drainage may be accomplished by a large gauze packing, or cigar-drain, or composite rubber tube and gauze drain, emerging through the median abdominal section. Or a subcostal lumbar incision may be made in the costovertebral angle and posterior drainage established under the guidance of the anterior opening, after which the latter is closed. Or drainage may be simultaneously established by both anterior and posterior routes. If posterior drainage be established, the inner end of the drain passes into the incised substance of the pancreas _ just as in the case of anterior drainage. The external wound or wounds are closed up to the exit of the drainage.

Comment.—It sometimes happens that the incision for drainage made into the pancreas will bleed considerably _ so that these drainage incisions into the gland may have to be sutured or packed.

It is well to bring the drain to the surface in a *conduit* of rubber or glass tubage _ thus protecting the drain-tract from the digestive property of the pancreatic fluid.

The gall-bladder should be examined, and if calculi be found, they should be removed and gall-bladder drainage established through a separate right-sided wound (especially if jaundice be present, _ unless the patient's condition forbid the necessary time). It must also be seen that the blockage of the common duct opening into the duodenum by a calculus in the ampulla of Vater is not present, as sometimes, as the causation of the pancreatitis (the bile thus flowing into the pancreatic duct and infecting it) _ and, if so, removed. While it is generally impossible to stop to remove the calculus in the usually desperate circumstances of these operations, the performance of a cholecystostomy will allow of outward drainage of the bile, which has been under the tension of blockage _ and the stone which blocks the ampulla can be removed when the patient's condition is better (Moynihan).

Sometimes the hemorrhage which follows the incisions into the pancreatic tissue is so severe that the small wounds into the gland tissue have to be first packed with gauze, and then the lips of the wounds sutured with plain catgut. The gauze drain is brought to the surface, and eventually its visceral aspect is released by the absorption of the catgut.

As the head of the pancreas is the part most often involved, and because of its position anterior to the vertebral column, posterior drainage is not so readily effected as drainage by the anterior route, though here, as elsewhere, it is better if posterior, extraperitoneal drainage can be secured. It is to be, however, remembered, as William J. Mayo remarks, that if a considerable part of the pancreas subsequently sloughs, the necrosed portions can be more easily removed from the front.

Adhesions are often found in these cases, and should be separated by blunt dissection, or divided between chromic ligatures, before attempting to expose the pancreas in the wound. While, in other cases, adhesions may be found walling off the general peritoneal cavity – so that it may, fortunately, be possible to incise directly through the abdominal wall and gastrohepatic (or gastrocolic) omentum, into the hemorrhagic or purulent organ.

Operation should be performed immediately upon discovery of the condition, or grave suspicion – and within twenty-four hours – before fat necrosis and secondary peritonitis occur. The four most prominent suggestive signs are: – marked pain in the epigastrium, violent vomiting, collapse, phenomena of intestinal obstruction.

Pancreatotomy and Drainage for Acute Pancreatitis by the Transgastro-colic Omental Route.—This is the route of choice of Kocher and of others. It has been described at p. 394, Fig. 3607. The transmesocolic route is sometimes also employed. The abdomen is opened as in the median section, and the gastrocolic omentum exposed. Having displaced the stomach upward and the transverse colon downward, the gastrocolic omentum is incised vertically, between the lower border of the stomach and the upper border of the colon – thus reaching the lesser peritoneal cavity. Having controlled all hemorrhage, the pancreas is reached through the opening in the omentum and drawn forward into the wound – packing off the vicinity with gauze. The gland is incised and its edges sutured into the lower plane of the abdominal wound or as near it as possible, having been brought through the rent in the gastrocolic omentum, which is sutured around the opening in the pancreas as well as possible. Drainage is provided for through the abdominal incision, which is usually accomplished by drainage-tube and gauze packing.

OPERATIVE TREATMENT OF SUBACUTE PANCREATITIS

BY INCISION AND DRAINAGE

Essentially the same characteristics are here present as in the acute form of the involvement, except that the degree of their manifestation is less marked – and the indications for operation are better defined – more time for the performance of which is given, and the results are better. Gangrene and suppuration are the likely conditions to be encountered.

On opening the abdomen, in the median line, above the umbilicus the same careful examination is made of the pancreas and of the neighboring structures, especially the gall-bladder tract. There is more apt to be a definable tumor or lesion – often, indeed, being detectable before the abdomen is opened. The position of the tumor is made out – and the method of drainage determined.

It is more frequently possible in the subacute than in the acute to secure posterior and extraperitoneal drainage – which, of course, is desirable. A left lumbar incision (more frequently than a right lumbar incision, as explained at p. 398) will often serve to drain these collections. The posterior abdominal wall can be safely incised while the hand within the abdomen guides the incision, which is made in one or the other loin, or in the costovertebral angle – after which the anterior abdominal wound is closed without drainage. Nevertheless, in the majority of instances, drainage will have to be instituted through the anterior abdominal wall, as in the acute cases – and in the same way – after the taking of every precaution against intraperitoneal soiling. Dark, grayish sloughs of pancreas are sometimes encountered. The pus is not so apt to be acrid, and may be even sterile.

It is usually well to conduct the gauze drain, from the site of involvement to the surface, in either a glass or split-rubber tube.

Pancreatic stones and gall-stones should both be sought – as well as any other cause likely to maintain trouble.

OPERATIVE TREATMENT OF CHRONIC PANCREATITIS

Chronic pancreatitis is a condition which results from the following causes: _ irritation from gall-stone, impacted either in the ampulla of Vater, or in the lower end of the common bile-duct (the commonest cause) _ from pancreatic calculi _ from extension of inflammation originating in gastroduodenal catarrh _ from extension from gastric or duodenal ulcer _ from outside pressure-obstruction of the duct _ possibly from injuries _ and from typhoid, syphilis, and alcohol.

The condition of chronic pancreatitis, supervening upon these causes, eventuates in an interstitial pancreatitis _ which may go on to such a degree of sclerosis of the viscus that the functionating part of the gland may be largely or entirely destroyed _ resulting in fatal diabetes.

The rational treatment of chronic pancreatitis, therefore, will rest upon the determination of which one or ones of the various causes may be in operation in the special case _ and the correction of that cause or causes. And as the tendency is toward progressive glandular destruction, much depends upon early surgical action _ even if not early pre-operative recognition _ for the phenomena are not pathognomonic.

Operative Treatment.—As the most frequent causes, by far, are surgical conditions, surgical steps are counted upon for relief _ and, fortunately, permanent relief is procurable in a large proportion of cases (dependent upon the nature of the cause) operated upon before too great destruction of the gland has occurred.

The operations for gall-stones are described below (v. Index) _ and for gastric and duodenal ulcers, at pp. 329–333. The operations for pancreatic calculi will be found at pp. 405–408.

The surgical procedure, naturally, is the recognition of the cause of the condition in the individual case _ followed by the necessary steps to remove that cause, where it is remediable.

As applicable to the majority of cases, the chief indication, after removing any definite cause present, is the drainage of the bile away from its usual course, preferably to the surface, for a period sufficient to enable the ducts to be relieved of infection.

Cholecystostomy (v. Index), with surface drainage for three or four weeks (at the end of which time it is discontinued, if no jaundice be present, and the bile be normal), is the best method of procedure. Cholecystenterostomy (v. Index) possesses a more desirable feature, in so far as the permanency of the drainage is concerned _ but a less desirable one, in that the likelihood of infection from the intestinal tract is constantly present, which is the very condition which the operation is planned to correct.

The abdomen is conveniently opened to the right of the median line, above the umbilicus. The sclerosed condition of the pancreas, especially its head, may often be recognized by palpation. Examination should be made for biliary calculi, the first commonest cause of the condition _ and then for pancreatic calculi. Even when no definite cause for the condition can be located, it is well to drain the gall-bladder by cholecystostomy for several weeks.

"The fundamental principle of surgical treatment," William J. Mayo writes, "consists in temporary or permanent disassociation of the pancreatic and liver ducts by relieving the common duct of as much of its bile-carrying function as possible. In about two-thirds of the cases the common duct passes through the head of the pancreas to reach the duodenum, and, in one-third, passes behind it. It will be readily seen that in two-thirds of the cases of pancreatitis, drainage through the common duct will be seriously interfered with and jaundice may be expected. In one-third of the cases jaundice will not necessarily be present, but even here the common duct will usually be found more or less dilated. Dilatation of the common duct may occur quite independently of gall-stone disease, and both the ducts and the gall-bladder may be considerably distended without noticeable jaundice. It will readily be seen that when the pancreas, as the result of infection, becomes swollen and causes pressure upon the common duct, it seriously interferes with biliary drainage, and, though the pancreas may have become involved secondarily, it prevents that free drainage of the liver secretions which is so essential to the relief of the infection upon which the pancreatitis depends. The surgical treatment of chronic pancreatitis is not usually directed to the pancreas itself unless pancreatic calculi or other foreign bodies be present, but rather to the biliary tract, and it is best accomplished by diverting the bile to the surface by means of a cholecystostomy, or to a new point in the gastro-intestinal canal by cholecystenterostomy."

In 2611 operations upon the gall-bladder and bile tract, the Mayos report that the pancreas was coincidentally involved 200 times, or in 7.6 per cent., of the cases _ and in 325 operations upon the common and hepatic ducts pancreatic involvement was found in 22 per cent. of the cases _ bearing out the known fact that the majority of cases of chronic pancreatitis are due to gall-stones either in the gall-bladder or biliary tract.

When the gall-stones are removed and free surface drainage established (cholecystostomy) the infection which the gall-stones caused is relieved _ and, as a result of this, the pressure of the pancreas upon the common duct is relieved soon after _ and the chronic pancreatitis is generally permanently cured. But, where the cause of the chronic pancreatitis is outside of the biliary tract, more lasting drainage of that tract is necessary than can be accomplished by surface drainage _ and, therefore, cholecystenterostomy is indicated.

Where cholecystenterostomy is performed, union of the gall-bladder with the duodenum (cholecystoduodenostomy) is the first choice, _ and the union of the gall-bladder with a high portion of the jejunum, by means of a 2-foot or 3-foot coil, which will readily pass around the transverse colon (cholecystojejunostomy), is the method of second choice. Cholecystogastrostomy and cholecystocolostomy have also been performed, but are undesirable.

OPERATIONS FOR PANCREATIC CALCULI

Pancreatic calculi usually consists of phosphate and carbonate of lime and sometimes of oxalate of lime. They are practically opaque to *x*-rays, by which they may be differentiated from gall-stones. They occur in all parts of the pancreatic duct _ but most frequently in the head, and least frequently in the tail. They may be rounded, coral-pronged, or sand-like _ and single or multiple.

Operation for the Removal of a Calculus from the Duct of Wirsung in the Body of the Pancreatic Gland (Fig. 3612).—The pancreas is most conveniently exposed for this procedure by elevating the liver, depressing and drawing the stomach to the left, and incising the gastrohepatic omentum, while the patient's back rests upon a sand-bag. Gauze packings are carefully placed to protect the surroundings from escaping pancreatic fluid, which, owing to its power of digesting tissues with which it comes into contact, is to be especially kept from such contact. As soon as the lesser sac is entered and the pancreas brought forward into the field, the organ is examined by palpation for the suspected calculus. If found, an incision is made through the peritoneum forming the posterior wall of the lesser sac, and which is reflected over the anterior surface of the pancreas — and the incision is then carried directly down through the pancreatic tissue, directly over the stone, and through the wall of the duct within which it lies — after which it is seized with delicate forceps and withdrawn. Bleeding is controlled as mentioned under wounds of the pancreas, p. 399. Visible vessels are ligated with fine catgut — or bleeding tissue is tied *en masse.* An attempt should be made to repair the incised duct by passing very fine catgut upon a curved needle, then through the outer part of the wall of the two lips of the wounded duct (but not entering its lumen), while the duct is steadied with fine forceps. The pancreatic tissue is then sutured over the incised gland (whether the latter has been successfully sutured or not) with a buried catgut suture or two. The peritoneum is sutured over the anterior surface of the gland. And a drain should, as an almost invariable rule be conducted from the surface of the pancreas through the abdominal wound — the opening in the gastrohepatic omentum being closed up to the passage of the drain through it.

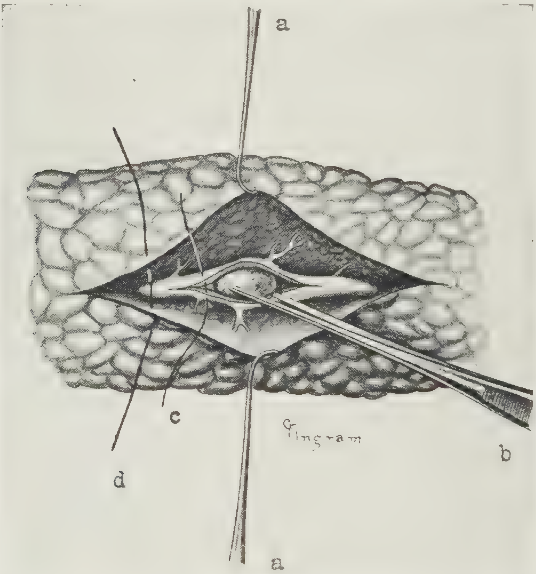


Fig. 3612.—Operation for the Removal of a Calculus from the Pancreatic Duct in the Body of the Pancreatic Gland, Followed by Repair of the Wound: — **a, a,** Retractors of the wound in the pancreas, made axially over the duct; — **b,** forceps, in the act of removing a calculus from the pancreatic duct, which has also been incised axially. Sutures are here shown in the position they would occupy when repairing the wound after the extraction of the stone; — **c,** fine, non-penetrating stitches of the duct wall; — **d,** heavier stitches of the gland substance.

Operation for the Removal of a Calculus from or Near the Opening of the Pancreatic Duct by the Transduodenal Route (Figs. 3613–3615).—The second portion of the duodenum is sufficiently mobilized (incising the peritoneum over the kidney, to its outer aspect, if necessary) to enable it to be brought into the field, after which an axial incision is made exposing its lumen and the lips of the incised intestine retracted The calculus may be found partly engaged within the opening of the duct in the papilla of Vater. If so, the duct should be compressed behind the stone, to prevent its recession, and then an attempt made to grasp the stone with fine, ribbed forceps, and extract it. If this cannot be done, or if the stone be felt, by probing, to be

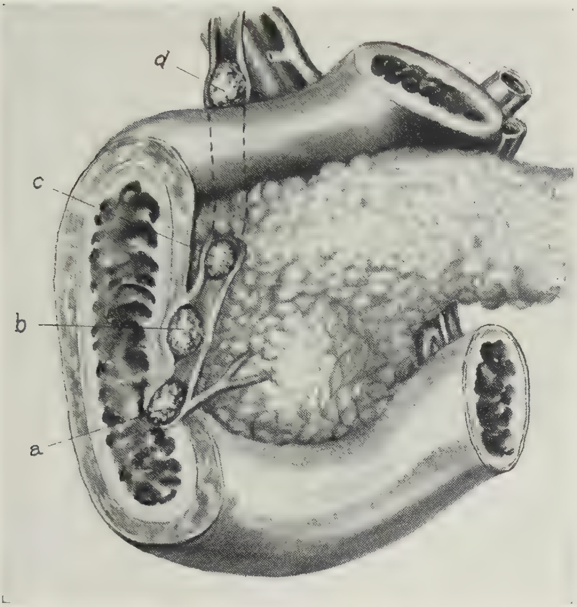
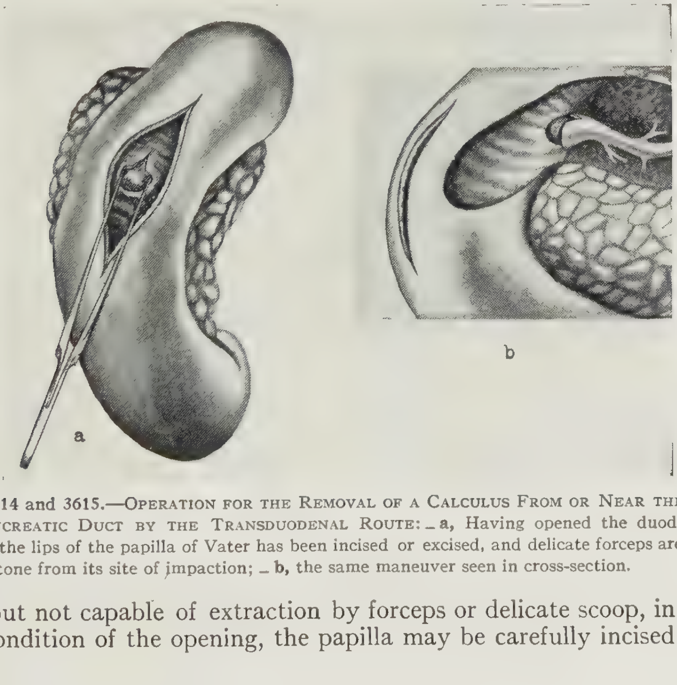


Fig. 3613.—Sites of Impaction of Calculi in the Common Duct:—**a,** Stone in the ampullary portion—which, if not removable after dilating the orifice of the ampulla through a duodenotomy wound, should be removed by transduodenal choledochotomy;—**b,** stone in the interstitial portion of the duct—which, if not capable of being manipulated into the supraduodenal, or ampullary parts of the common duct, should be removed by transduodenal choledochoduodenostomy;—**c,** stone in the retroduodenal portion of the common duct—which should be removed by retroduodenal choledochotomy;—**d,** stone in the supraduodenal part of the common duct.



Figs. 3614 and 3615.—Operation for the Removal of a Calculus From or Near the Opening of the Pancreatic Duct by the Transduodenal Route:—**a,** Having opened the duodenum, one (or both) of the lips of the papilla of Vater has been incised or excised, and delicate forceps are in the act of lifting a stone from its site of impaction;—**b,** the same maneuver seen in cross-section.

nearby, but not capable of extraction by forceps or delicate scoop, in the unaltered condition of the opening, the papilla may be carefully incised—either limitedly cutting a single lip or both lips _ and then removing the calculus by delicate forceps or scoop. At the end of the operation the incised lip, or lips of the papilla, are repaired by suture with fine catgut, if considered advisable _ the opening in the duodenum repaired _ the duodenum replaced (and the incised peritoneum upon its outer aspect, over the right kidney, sutured, if it have been cut) _ and the abdomen closed. Drainage is not indicated by the operation, *per se*, if the opening be through the duodenum _ (but is generally indicated if the substance of the gland have been cut into in removing a stone from the body of the gland).

Operation for the Removal of a Calculus in the Head of the Pancreas, but Not in the Pancreatic Duct.—If the calculus lie more forward, an incision is made through the overlying peritoneum, and the head of the pancreas carefully separated from the duodenum, to admit of its satisfactory exposure _ when the stone is cut down upon directly _ and the wound of the glandular tissue repaired by suturing with catgut. If the calculus be situated more posteriorly, the entire second portion of the duodenum may be mobilized, by incising the peritoneum to its outer aspect, over the right kidney (Fig. 3621) _ and then turning the second portion of the duodenum and head of the pancreas, *en masse*, forward and toward the median line _ thus exposing the posterior surface of the pancreas _ after which the substance of the gland is cut into, and subsequently repaired, as elsewhere.

Comments.—It must not be taken for granted that because one stone has been located and removed, no other stone or stones may be present _ until the latter are excluded by careful examination.

A limited incision through one or both lips of the papilla of Vater, for the purpose of gaining access to a stone at the outlet, or nearby, need not be sutured, and probably is better not sutured, as likely to lead to constriction if the suturing be overdone _ but any extensive cutting should be repaired, in part at least.

OPERATIONS UPON CYSTS OF THE PANCREAS

Cysts of the Pancreas are divisible into: _

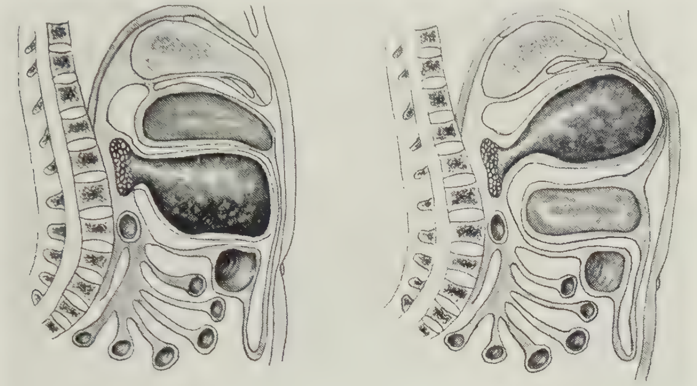
(A) True cysts; _ Congenital cystic degeneration, _ Retention cysts (due to outside pressure, stenosis, calculus, or partial displacement), _ Hydatid cysts, _ Hemorrhagic cysts, _ Proliferating cysts (adenomatous and carcinomatous).

(B) False cysts; _ Distention of the lesser peritoneal sac by fluid, _ or Localized collection of fluid in proximity to the pancreas.

Routes of Development of Pancreatic Cysts.—As cysts originating from the pancreas cannot progress backward, owing to the solidity of the posterior osseomuscular wall opposite which the pancreas lies, their only avenue of forward extension is, of course, by pushing their anterior peritoneal covering (which is also the posterior wall of the lesser sac) ahead of them, and growing forward between adjacent organs and structures, either upward, downward, or laterally. The commoner routes of forward extension are the following: _

(A) **Forward Extension of Cyst Between Stomach and Transverse Colon** (Fig. 3616, **a**).—This is the most frequent route by which the cyst reaches the surface. To expose the cyst in the median line one cuts through the parietal peritoneum, the two layers of the gastrocolic omentum, and the layer of peritoneum forming the posterior wall of the lesser sac.

(B) **Forward and Upward Extension of Cyst Between Stomach and Liver** (Fig. 3617, **b**).—To reach the pancreas in the middle line, one here incises the parietal peritoneum, the anterior and posterior layers of the gastrohepatic omentum, and the posterior layer of the lesser sac.

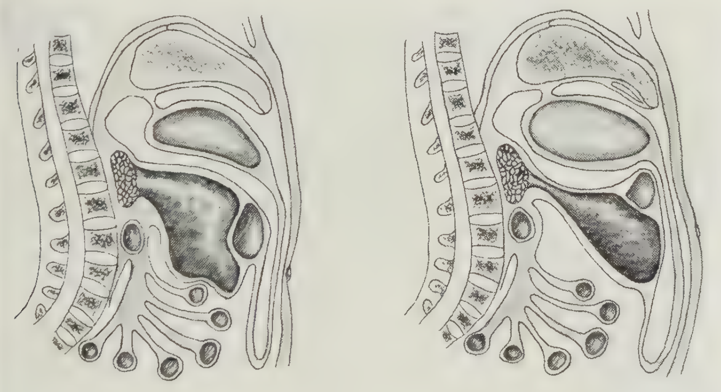


a

b

Figs. 3616 and 3617.—Routes of Development of Pancreatic Cysts: _ **a,** Forward extension of cyst between stomach and transverse colon; _ **b,** forward and upward extension of cyst between stomach and liver.

(C) **Forward and Downward Extension of Cyst Between the Layers of the Transverse Mesocolon and Behind the Transverse Colon** (Fig. 3618, **c**).—The colon here crosses the front of the cyst, the cyst weighing down the inferior layer of the transverse mesocolon. To reach the cyst in the median line two alternatives present themselves, _ If one approaches above the transverse colon, the parietal peritoneum, both layers of the anterior fold of the great omentum, and the bulged-forward posterior layer of the lesser sac are to be cut, _ If one approaches below the transverse colon,



c

d

Figs. 3618 and 3619.—Routes of Development of Pancreatic Cysts: _ **c,** Forward and downward extension of cyst, between the layers of the transverse mesocolon, and behind the transverse colon; _ **d,** forward and downward extension of cyst, between the layers of the transverse mesocolon, bulging downward the inferior layer, until the cyst comes to lie below the transverse colon, which then crosses above it.

one cuts the parietal peritoneum, displaces upward the great omentum, and incises the bulged-forward posterior layer of the sac, which covers the anterior aspect of the cyst.

(D) **Forward and Downward Extension of Cyst Between the Layers of the Transverse Mesocolon, Bulging Downward the Inferior Layer Until the Cyst Comes to Lie Below the Transverse Colon, which Then Crosses Above It** (Fig. 3619, **d**).—The stomach and transverse colon lie above the cyst. In reaching such a cyst in the middle line one incises the parietal peritoneum, the two layers of the anterior fold of the great omentum, and the anterior layer of the posterior fold of the great omentum.

Operative Treatment of Cyst of the Pancreas by Anchorage to the Abdominal Wall, Incision, Evacuation, and Drainage (Fig. 3620).—This is the method most generally carried out — and with very satisfactory result. The incision of the abdominal wall is usually made over the most prominent part of the tumor when the contour is evident. Otherwise the approach is by median incision. The technical details of exposure, after the abdomen is once opened, will depend upon the route of development of the cyst — which is generally in one of the directions already described. If there be no element of haste, and the cyst reaches far enough forward, it can be anchored, with catgut sutures, into the aponeurosis of the deeper plane of the wound of approach — the rest of the wound being sutured up to this anchorage — and opened later (in from four to seven days) after adhesions have shut off the general peritoneal cavity. If there be need of completing the operation at once, and the cyst will reach to the abdominal wall, it can be evacuated by syringe, or trocar and cannula (to avoid soiling the cavity), and then the evac-

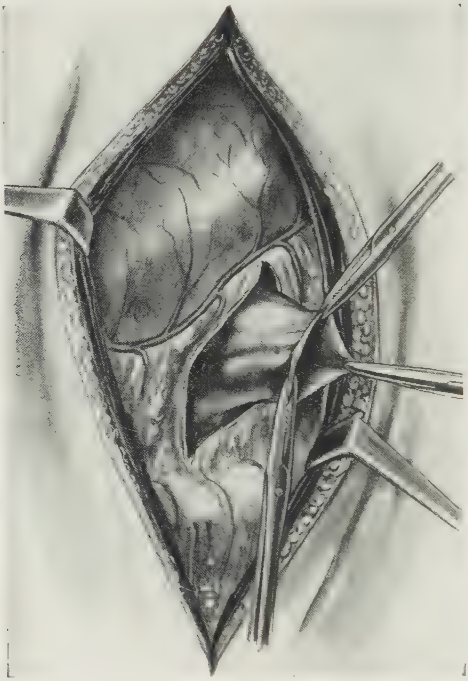


Fig. 3620.—Drainage of a Pancreatic Cyst Exposed Through the Gastrocolic Omentum; — Its incised anterior wall is about to be anchored in the abdominal wound.

uation opening enlarged and sutured into the deeper aponeurosis of the wound. If the cyst be of such size, or so placed, as not to reach the abdominal wall, it is generally best to evacuate it by trocar and cannula _ enlarge the opening in the cyst _ place a rubber tube within the cyst, anchoring it by a suture or two of catgut to the rubber tube _ placing a purse-string suture around the cyst neck and drawing the cyst closely around the rubber tube _ and then bring the rubber tube through the abdominal wound. By the time the rubber tube comes away, peritoneal adhesions have formed a drainage channel. During all these procedures the adjacent structures are protected from soiling by plentiful gauze packing. The cyst is always covered with peritoneum, and this should always be sutured to the parietal peritoneum with fine catgut. Some Surgeons anchor before evacuating, in the first stage operation _ but it seems easier to keep from soiling the surroundings if the evacuation be first made, when every precaution can be taken against soiling. This, of course, has reference only to the one-stage operation. After evacuation the trocar opening is clamped during the anchorage of the cyst to the abdominal wall. Drainage is best accomplished through a rubber tube. Sometimes, after the anterior exposure, one makes a posterior opening into the cyst sac by an incision in the costovertebral angle, below the last rib, guided by a finger within the cyst cavity _ after which the anterior opening is also drained in the manner just described, or it is closed by suture, and the posterior opening only is used. Sometimes, instead of resorting to immediate evacuation of the fluid, especially in a cyst too short to reach the abdominal wall, gauze is packed down to the cyst and brought out of the wound _ and when the gauze is withdrawn, in about three days, adhesions will have formed, and the cyst may be incised without danger of soiling.

Operative Treatment of Pancreatic Cyst by Excision of the Cyst, Partial or Complete.—This method, as theoretically desirable as it is, is practically rarely capable of execution _ owing to the very dense and firm adhesions which usually bind down the cyst, to the friable nature of the parts involved, and to the hemorrhage from important vessels which are apt to be torn. In exceptional instances, however, the method may be applied _ namely, when the cyst presents somewhat of a pedunculated attachment with the pancreas, and when the separation of its wall from its bed is relatively easy and simple. Operations by enucleation by some of the most skilful Surgeons have had to be abandoned in their midst because of difficulties encountered. If the pedicle can be exposed, it may be clamped, ligated, and divided _ as a near approach to complete enucleation.

Operative Treatment of Pancreatic Cyst by Aspiration.—By this is meant aspiration through the skin _ and, apart from the fact that the cyst almost invariably refills, to say nothing of the dangers of leakage during refilling, the method is absolutely unsurgical _ and unwarrantable. Even when it has been recommended in patients in too bad condition for any other procedure, such cysts as could be reached through a blind thrust into the abdominal cavity, could also be exposed under analgesia, and the cyst wall first sutured into the abdominal aponeurosis before being incised _ or be packed down to the cyst wall, and opened several days later. Evacuation of the cyst contents by aspiration, after the abdomen is opened, and before proceeding with some other special technic, is entirely warrantable.

Comments.—A fistulous tract may remain after the withdrawal of the drain _ and may even continue for many weeks, or longer. As a rule, however, it is exceptional for a condition of fistula to continue in these cases. It usually closes inside of three or four months. When present, and especially when persistent, the skin may be much irritated by the digesting juice that escapes upon it. Matters are somewhat helped by keeping a rubber drainage-tube in the sinus, the outer end of which is made to empty into a rubber bag. (See Operations for Pancreatic Fistulæ, p. 412.)

It is simpler and safer to first try anchorage, incision, and drainage in dealing with pancreatic cysts – reserving excision for those few cases in which the tumor refills, or for those cases where the tumor is pedunculated or otherwise favorably environed.

When the cyst is not large enough to reach the abdominal wall, to be anchored in the aponeurosis for drainage, the rubber tube is tied into an incised opening into the cyst wall exactly as is the case in gall-bladder drainage (q. v.). In such cases it is well to surround the tube with gauze packing, at least limitedly. When the rubber tube comes away, by digestion of the retentive catgut suture, and the surrounding gauze, a convenient substitute for these is a velvet-eyed rubber catheter, of the maximum size that will enter the tract and pass on into the cystic sac. The surface of the wound should be lubricated to prevent excoriation by the irritating fluid.

Instead of resorting to the above described method of draining cysts which are too short, or too awkwardly placed to reach the surface, unless the intervening distance is bridged by rubber tubing or gauze packing, or both – one may often make a posterior counteropening through the loin below the costal arch, guided by a finger introduced from within the opened abdomen, and into some more posterior aspect of the cyst – temporarily anchoring it there with a catgut suture. If an opening have already been made into the anterior aspect of the cyst, this may be sutured up by a through-and-through marginal catgut suture, reinforced by a tier of serous sutures. If indicated, for further guarding against leakage, a strip of gauze can be carried from this anterior opening of the cyst, through the anterior abdominal incision, temporarily.

OPERATIVE TREATMENT OF PANCREATIC FISTULÆ

Pancreatic fistulæ occur, most frequently, as the postoperative result of operative measures employed for the cure of pancreatic cysts, but are sometimes the result of wounds – according to some authorities, persistent fistula, following cyst drainage, is the exception – according to others, the rule.

The minor measures resorted to for the cure of these fistulæ are the same as those employed for fistulæ elsewhere – such as cauterization, curetage, dilatation – and are usually ineffective and may be dangerous.

Wohlgemuth's dietary treatment is sometimes adopted as a sole measure, or is used following some operative step for relief.

The major measures resorted to for pancreatic fistulæ are such considerable procedures that one should first make sure to rule out other abdominal fistulæ, connected with the gastric, intestinal, biliary, and urinary tracts. It has been held by some that a temporizing period of about nine months should be observed for spontaneous closure before resorting to operation.

Operation for Pancreatic Fistula by Excision.—Postoperative fistula, following the adoption of drainage for the cure of pancreatic cyst, usually argues that the cyst was not capable of radical excision at the time of original exposure, or that it would have been then removed, as a radical and ideal measure – so that subsequently, when attacked as a pancreatic fistula the supposition reasonably is, that even additional difficulty would be experienced – as more or less extensive adhesions are now added to most of the conditions originally present. This is borne out by the fact that several attempts at excision have been resorted to in such cases – with failure, and abandonment of the attempt. Nevertheless, exceptionally, the pancreatic fistula has enbe successfully excised, with closure, by suture, of its proximal end.

Operation for Pancreatic Fistula by Pancreaticoduodenostomy.— The pancreatic fistula, where its course is favorably situated to that end, has been dissected up sufficiently to admit of its being anastomosed with the lumen of the duodenum. This technic has been successfully carried out by Ombrèdanne.

Operation for Pancreatic Fistula by Pancreaticocholecystostomy.— Kehr has successfully implanted the pancreatic fistula into the gall-bladder.

Operation for Pancreatic Fistula by Pancreaticogastrostomy.— Doyen and Michaux have been successful in anatomosing the fistula with the stomach. Michaux, guided by a probe within the fistula, dissected it out _ and then, excising its cutaneous end, buried its proximal portion in the stomach wall after the method of the Witzel gastrostomy technic.

OPERATIVE TREATMENT OF SOLID TUMORS OF THE PANCREAS

The most common solid tumor of the pancreas is carcinoma _ and its most frequent situation the head of the gland. The next most common is sarcoma. Adenoma probably comes next. Benign tumors are very rare.

Infiltrating tumors of the head of the gland practically require the total excision of the gland _ which may be considered prohibitive.

In tumor of the pancreas, associated with obstructive jaundice, the low coagulability of the blood in such cases is to be remembered in planning operative measures.

Moynihan summarizes the conditions under which attempt at the removal of solid tumors of the pancreas may be considered justifiable to be: _ When the tumor has a pedunculated contour, _ when it is possible to enucleate it, _ when it is situated in either the tail of the pancreas, or in the portion of the body adjacent to the tail, _ when the vascular adhesions are not such, either by nature or number, as to make the mechanical accomplishment of the removal almost impossible.

In cases of malignancy where the bile flow is obstructed, and radical operation is contraindicated, palliative measures may sometimes mitigate the patient's condition _ such as cholecystostomy or cholecysto-enterostomy.

In those cases where the removal of the tumor is undertaken the two routes of approach most frequently taken are the gastrocolic and the gastrohepatic _ dependent upon the position, nature, and condition of the tumor.

The portion of the pancreas holding the tumor is sought, and brought as well forward as possible. If the tumor be enucleable, an attempt is made to shell it out of its bed by blunt dissection _ a blunt metallic spoon or other form of blunt dissector often serving the purpose well.

Sometimes one will undertake to remove a tumor which appeared enucleable, but proves not _ or even undertake to remove one known not to be enucleable _ and, in such instances, it is well to previously surround the bed from which the tumor is to be excised by interlocking chromic catgut ligatures _ after which the tumor is cut away by blunt, curved scissors. All bleeding vessels are ligated with catgut. The bed of the tumor is brought together by sutures of chromic catgut, if it be possible to do so, to further control bleeding.

The ducts of Wirsung and Santorini are safeguarded, in the enucleation or excision of tumors.

Temporary drainage to and through the abdominal wound is employed. The abdominal wound is closed up to the drain.

PANCREATECTOMY, PARTIAL AND COMPLETE, IN GENERAL

The surgery involved in the removal of a part, or the whole of the pancreas, whether for one pathologic condition or another, is in a distinctly formative stage. The indications have not been definitely determined _ nor the safe range of possibility _ nor the operative technic. In some of the latest works upon Operative Surgery, pancreatectomy, both partial and complete, is either not mentioned, or passed over in a few indeterminate words.

What has been just said is true _ although the head, or the body, or the tail, or the whole pancreas has been successfully removed _ though the mortality has been high in the major types of operation.

Excision of the tail of the pancreas presents no great difficulty _ nor of the tail and the part of the body next adjacent _ and the circumstances under which these parts have been removed have usually been in connection with tumors.

Many of the difficulties of partial pancreatectomy, especially of the head of the pancreas, are removed by the performance of total pancreatectomy, as far as making provision for the parts of the pancreas and the disconnected structures left behind are concerned.

As Franke, in 1891, and Billroth, in 1894, each removed the entire pancreas, in patients who recovered, the feasibility of its successful removal would seem to have been established.

Relatively little advancement in the surgery of the pancreas is largely due to the combination of comparatively meager knowledge of the biochemistry of the organ _ and to the technical difficulties and dangers encountered in the operative procedures.

The chief indications for the removal of more or less of the pancreas are tumors, the vast majority of which are malignant _ and, in many of the cases, extensive metastases are found upon exposure of the parts, which preclude the feasibility of ultimately successful operation.

The surgical treatment of tumors of the pancreas is by pancreatectomy, partial or total _ and by palliative operations.

If part of the pancreas be removed, provision must be made to provide for the secretion of the remaining stump _ especially if the head be excised.

Excision of the tail of the pancreas, or of part of its body, is the simplest procedure, and has yielded the best results _ as, also, enucleable tumors of the head, not necessitating damage to the ducts of Wirsung and Santorini.

To remove the head of the pancreas requires, almost of necessity, resection of the duodenum, for it involves severing the gastroduodenal artery, which, in turn, involves gangrene of the duodenum. And in pancreatoduodenectomy, the portal vein, inferior vena cava, and superior mesenteric artery are exposed to considerable danger _ the duodenum must be resected _ as well as the common bile-duct, and the ducts of Wirsung and of Santorini _ following which provision must be made for the emptying of the secretions from these ducts into the gastro-intestinal tract and the transversely divided body of the pancreas should be covered by peritoneum. The method of accomplishing these ends by Désjardin's operation of pancreatoduodenectomy will be described.

Guleke collected 24 cases of excision of the pancreas _ of which there was an operative mortality of 12 _ and, of the other 12, the longest survival was for an interval of five months, death following malignant recurrence.

The total removal of the pancreas has been proved to be technically possible _ and compatible with survival of the immediate operation.

Kehr did palliative operations upon 71 cases of pancreatic carcinoma _ of whom 10 lived in marked improvement for two years.

When the duct of the pancreas is closed by mass ligature the rest of the gland atrophies. Whether the "inner secretion" remains is questionable (Koerte).

The total removal of the pancreas involves great technical difficulties – as well as the danger connected with the development of diabetes – and the loss of the pancreatic digestive fluid.

DÉSJARDIN'S PARTIAL PANCREATODUODENECTOMY, FOLLOWED BY GASTROJEJUNOSTOMY, CHOLEDOCHOJEJUNOSTOMY, AND PANCRETOJEJUNOSTOMY

Description.—This technic probably represents the best method of procedure in these cases which has been worked out up to the present time.

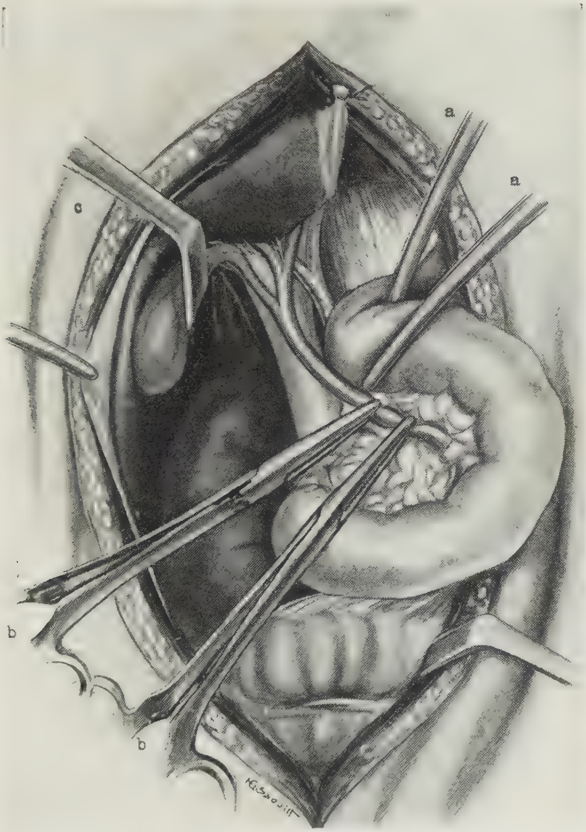


Fig. 3621.—Désjardin's Partial Duodenopancreatectomy – I; – The duodenal horseshoe has been mobilized and turned forward, along with the attached head of the pancreas. The gall-bladder, **c**, is retracted upward, along with the liver, exposing the structures in and behind the hepatoduodenal ligament – the common duct, vena portæ, and hepatic artery. The upper end of the duodenum is clamped at its pyloric junction and just beyond, **a, a**. The pancreatic duct is doubly clamped (by clamps which should be non-traumatizing) near to its entry into the duodenum in common with the duct of Wirsung (possibly nearer than here shown).

Its chief field of application is in cases of tumors of the head of the pancreas. The steps of the complex operation are briefly described below – and illustrated in the accompanying pictures

Operation.—A median incision is made, extending from the level of the anterior end of the ninth rib nearly to the umbilicus. The upper end of this incision is continued still upward and to the right, through the right rectus muscle, until the costal arch is reached, to the median side of the gall-bladder. When additional room is required the lower end of the incision is carried obliquely downward and to the left. An intra-abdominal examination is made through the median incision alone before the additions to it are made.

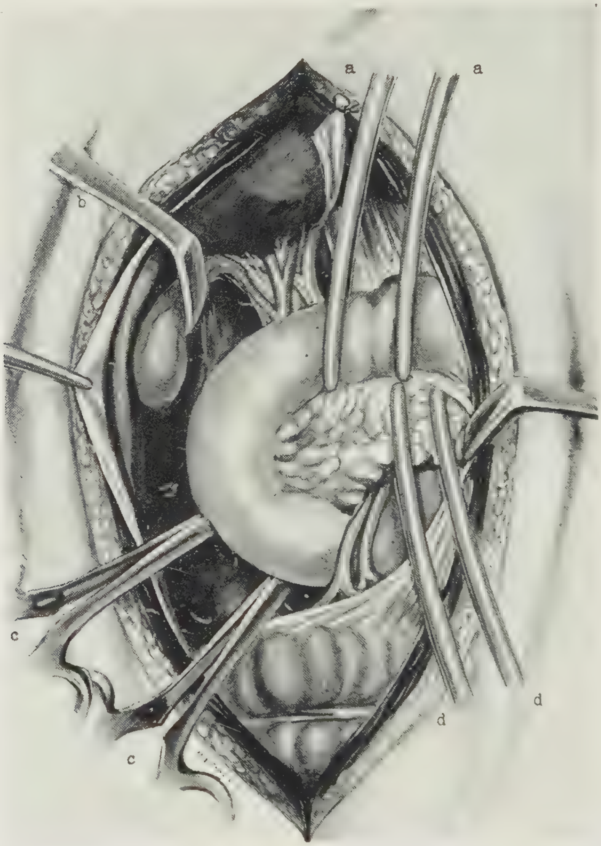


Fig. 3622.—The Same — II: — **a, a,** The proximal aspect of the duodenum, lightly clamped; — **c, c,** double clamps of the pancreatic duct (see preceding picture); — **d, d,** head of the pancreas, lightly clamped; — **b,** retracted liver and gall-bladder. The entrance of the foramen of Winslow is seen between this clamp and the hepatoduodenal ligament.

The omentum is displaced to the left, exposing the duodenum. The duodenum and included head of the pancreas are then mobilized by a curvilinear incision over the kidney, placed about 2 cm ($\frac{3}{4}$ inch) to the outer side of the second portion of the duodenum. The duodenal angle and the head of the pancreas are carefully separated from the posterior abdominal wall by combined sharp and blunt dissection — displacing them forward and mediad until the portal vein and vena cava are passed. The head of the pancreas is thus sufficiently mobilized for the necessary surgical manipulations (Fig. 3621).

The pyloric and gastroduodenal vessels are ligated. The right aspect of the great omentum is freed — dividing it, as may be necessary, between ligatures.

The common bile-duct is exposed, doubly clamped, and divided between the clamps (as low as possible, if dilated — otherwise, just below the junction of the cystic duct). The pyloroduodenal junction is mobilized sufficiently to apply double clamps (Fig. 3622) — after which the duodenum is divided between them. The duodenum and pancreas are to be mobilized up to the site of and beyond the superior mesenteric vessels. Sometimes it is necessary to dissect the mesocolon in order to expose the part of the duodenum lying beneath it. The mobilization of the duodenum is continued past the superior mesenteric vessels — until the duodenojejunal junction is reached — at which site the bowel is doubly clamped and divided.

The head of the pancreas and the angle of the severed duodenum remain attached to each other Two parallel clamps are carried obliquely upward and to the right, controlling the pancreas — avoiding the colica media vessels — and between these the pancreas is divided. The head of the pancreas, with the attached "horseshoe" of the pancreas, is then removed — safeguarding the superior mesenteric vessels, which pass downward between them.

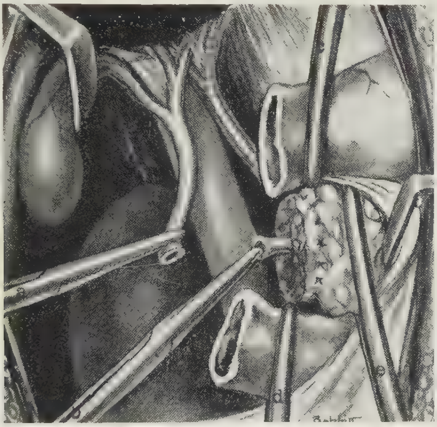


Fig. 3623.—The Same — III; — The pyloric end of the stomach and distal end of the duodenum are clamped. The divided pancreas is lightly clamped. Clamps (which should be non-traumatizing) are holding the divided ends of the common and pancreatic ducts.

Two female Boari buttons are dropped into the lumen of the jejunum (so clamping the part below as to keep them from slipping beyond control). Insert, in the usual manner, the male Murphy button into the pyloric end of the stomach — and the female Murphy button into the open end of the jejunum — and anastomose these structures — Figs. 3623 and 3624. (Instead, sometimes the pyloric end of the stomach is closed, after dropping the male Murphy button into the stomach — and then the free end of the jejunum is buttoned to the posterior wall of the pyloric aspect of the stomach, constituting a posterior jejunogastrostomy rather than an end-to-end jejunogastrostomy.)

The outer aspect of the jejunum is then limitedly incised, and the female Boari button pushed through — to which is buttoned the common bile-duct, into the free end of which a male Boari button has been inserted — the site being reinforced by ligatures.

Having controlled bleeding from the pancreatic stump by interlocked, or other form of ligaturing, isolate the distal end of the duct of Wirsung (having carefully avoided ligating it) and place a male Boari button within its lumen. The corresponding shank of the female Boari button, which had been dropped into the jejunum, is brought out through a limited incision in the median aspect of the jejunum and an anastomosis between the remains of the pancreatic duct and the jejunum is made.

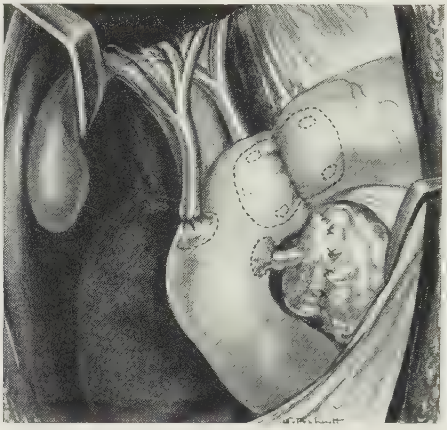


Fig. 3624.—The Same – IV; – The pyloric end of the stomach and the distal end of the duodenum have been anastomosed by means of Murphy buttons. The ends of the common duct and of Wirsung's duct are anastomosed with the sides of the duodenum by means of Boari buttons.

The completed technic is seen in Fig. 3624.

CHAPTER LXVIII

OPERATIONS UPON THE SPLEEN

Surgical anatomy, p. 419; – General surgical considerations, p. 420; – Surface form and landmarks, p. 420.

Exploratory puncture of the spleen, p. 420; – Splenotomy for abscess by oblique subcostal incision, p. 421; – If the spleen be adherent at the site of exposure, p. 421; – If the spleen be non-adherent at the site of exposure, p. 421; – If the spleen be non-adherent at the site of exposure, and no need of immediate incision of the abscess be present, p. 422; – Exposure of the spleen by the subpleural route by the partial excision of one or two ribs, p. 423.

Operative treatment of wounds of the spleen, p. 423; – Splenorrhaphy, p. 424.

Methods of splenopexy for splenoptosis, p. 424; – Splenopexy by the Rydigier method, p. 424; – Splenopexy by the Bardenheuer method, p. 426; – Tuffier's method, p. 427; – Greiffenhagen's method, p. 427; – Kouwer's method, p. 427; – Schiassi's method, p. 427.

Partial splenectomy by subcostal incision parallel with the ribs, p. 427; – Total splenectomy, p. 428.

SURGICAL ANATOMY

Description and Situation.—Situated chiefly in left hypochondriac region – lying above the left kidney and splenic flexure of colon – between concavity of diaphragm to left and behind, and fundus of stomach to right and in front – corresponding, in axillary line, with ninth, tenth, and eleventh left ribs. It lies obliquely from above downward and from within outward. Its length is about 12 cm. (4¾ inches) – breadth, 8 cm. (3¼ inches) – thickness, 3 cm. (1¼ inches). The peritoneum entirely surrounds the spleen except at its hilum – which is at the center of the internal surface (between the renal and gastric portions of internal surface) through which the arteries and nerves enter and the veins and lymphatics emerge. Its pedicle is formed by the reflection of peritoneum over the vessels at the hilum. The diaphragm separates all parts of the normal spleen from the parietes. The spleen may be absent, or there may be from one to twenty more or less rudimentary spleens present.

Surfaces and Borders.—Phrenic surface; lies beneath left ninth, tenth, and eleventh ribs – peritoneum, diaphragm, portions of left pleura and lung, the costophrenic sinus (and sometimes left lobe of liver) intervening. **Renal part of internal surface**; touches superior and external part of left kidney, and generally the suprarenal capsule. **Gastric part of internal surface**; in contact with posterior wall of a filled stomach. **Basal surface** (lower outer end); in contact with splenic flexure of colon and phrenocolic ligament (and often with tail of pancreas). **Anterior margin**; situated between diaphragm and stomach. **Posterior border**; between diaphragm and left kidney. **Superior end**; on level with tenth dorsal vertebra, approaching within 2 to 3 cm. (¾ to 1¼ inches) of spinal column. Reaches to level of ninth dorsal spine. **Inferior end**; limited anteriorly by costoclavicular line (connecting left sternoclavicular articulation with anterior end of eleventh rib). Reaches to level of first lumbar spine.

Relations.—Externally and Superiorly; peritoneum; diaphragm; left ninth, tenth, and eleventh ribs; costophrenic sinus; left lung and pleura; posterior thoracic muscles. **Inferiorly**; splenic flexure of colon; phrenocolic ligament; tail of pancreas (sometimes). **Internally**; stomach (posterior surface of fundus); left kidney and capsule; tail of pancreas; spinal column (sometimes).

Relations of Spleen to Thoracic Cavity.—Upper third of spleen is covered by left lung, _ middle third is in contact with left costophrenic sinus, _ lower third passes below lower pleural limit and costal origin of diaphragm.

Ligaments and Fixations of Spleen.—Gastrosplenic omentum _ from hilum to fundus of stomach. Phrenosplenic ligament _ from upper end of spleen to diaphragm. Spleno-renal ligament _ formed partly by greater and lesser peritoneal sacs _ contains the splenic vessels. Phrenocolic ligament _ affords support, though not connected with spleen. Pancreaticosplenic ligament _ present when tail of pancreas does not reach spleen. Splenocolic ligament _ from basal aspect of spleen to colon (sometimes present).

Arteries.—Splenic.

Veins.—Splenic.

Lymphatics.—Empty into glands at hilum.

Nerves.—From celiac plexus and right pneumogastric.

GENERAL SURGICAL CONSIDERATIONS

The spleen may be exposed in several ways _ by oblique subcostal incision parallel with the costal arch; by vertical incision in the left linea semilunaris; by vertical incision to the left of the left linea semilunaris; by median abdominal incision; by intercostal incision; by partial excision of one or more ribs, followed by subpleural or transpleural exposure of the spleen. If more room be needed, any of the vertical incisions may be increased by a transverse or curved incision extending toward flank or median line, from the lower part of the vertical incision. Where an abdominal incision is first made for pure exploratory purposes, the median abdominal incision is probably best. There is general similarity in the technic of hepatic and splenic operations. The freest exposure of the splenic region, as of the hepatic region, is secured by the temporary resection of the costal cartilage.

For further considerations of the methods of exposing the spleen, see Incisions, under Total Splenectomy, p. 428.

SURFACE FORM AND LANDMARKS

The upper end of the spleen lies opposite the level of the ninth dorsal spine _ lower end, opposite the level of the first lumbar spine. The inner border comes within 3.8 to 5 cm. (1½–2 inches) of the median plane of the body. The outer border lies just posterior to the midaxillary line _ not coming further forward than a line joining the left sternoclavicular articulation and the anterior end of the eleventh rib. The spleen corresponds with the ninth, tenth, and eleventh left ribs _ separated from them by the diaphragm and, in its upper part, also by the lung. Its long axis about corresponds with the line of the left tenth rib. It slightly overlaps the outer border of the left kidney below.

EXPLORATORY PUNCTURE OF SPLEEN

Exploratory puncture of the spleen is made in the same general manner, and with the same general precautions, as is exploratory puncture of the liver (see page 440). As in the case of the liver, exploratory puncture of the spleen is rarely warrantable, owing to the risks of sepsis and hemorrhage _ and should not be used except in the case of tumors, which are almost certainly adherent to the abdominal wall, thus shutting off the general peritoneal cavity _ and especially in those projecting below the ribs. The site of the tumor and the general relations given under Surgical Anatomy will serve as the guide for the site of puncture _ the puncture itself being made exactly as it is in the case of the liver.

SPLENOTOMY FOR ABSCESS

BY OBLIQUE SUBCOSTAL INCISION

Description.—Incision of the spleen is usually called for in abscess, and in cysts, and sometimes as an exploratory measure. The single step of incision, followed by splenorrhaphy, completes the operation, as far as the spleen is concerned, where only an exploration of the splenic substance is made, and is not followed by any other operation. On the other hand, where splenotomy is performed for pus or other fluid, the act of incising the spleen is only one act of a threefold procedure _ the other acts being anchorage (marsupialization, if the spleen be non-adherent to the abdominal wall) and drainage. The site of incision usually lies directly over the point of manifested pus, or the tumor, if one exist. In the absence of these, one of the routes of exposure (v. i.) will be selected which seems to best fulfil the conditions of the case _ in the present instance, by the oblique subcostal incision. Where the spleen is found adherent to the abdominal wall, incision can be made directly into the splenic substance, without further preparation. If the spleen lies free in the abdominal cavity, and the element of haste is present, the surface of the spleen may be sutured to the abdominal wall, and then incised at once (although some degree of soiling is apt to occur). If no haste be present, the spleen may be anchored to the abdominal parietes, with catgut sutures, and be subsequently incised, when adhesions will have closed off the abdominal cavity.

Preparation _ Position.—As for abdominal section. The patient may be turned slightly to the opposite side in order to cause the field of operation to present somewhat more conveniently.

Landmarks.—Lower border of the left costal arch; left linea semilunaris; anterior axillary line; position of the tumor, if any.

Incision.—The oblique incision runs parallel with, and about 1.3 cm. ($\frac{1}{2}$ inch) below the left costal arch, with its center over the spleen (the inner border of which comes to within 4 to 5 cm. [$1\frac{1}{2}$–2 inches] of the median plane _ and whose outer border extends just posteriorly to the midaxillary line).

Operation.—The steps of the procedure, up to the exposure of the spleen, are practically the same as in the corresponding operation upon the liver (the exposure of the liver by an oblique right subcostal incision, p. 441), with the sides of the body transposed. The details are there given for incising and repairing the abdominal muscles, and avoiding the nerves. Having entered the abdomen, the condition of the spleen is examined _ as to whether it is adherent at the site of exposure (which, if so, is particularly fortunate in the evacuation of fluids from its interior), or whether free in the cavity. One of three methods of procedure, from this point onward, will generally be available.

(*a*) **If the Spleen Be Adherent at the Site of Exposure.**—This is the simplest of the alternatives. An exploratory puncture (which is warrantable in an open abdomen) may be made with needle and aspirating syringe, to corroborate the diagnosis _ to be followed immediately, if the puncture be confirmatory, by an incision directly into the pus cavity. Or, if reasonable certainty exists, incision may be made directly into the abscess without preceding puncture _ and drainage established.

(*b*) **If the Spleen Be Non-adherent at the Site of Exposure _ and Need for Incision of the Abscess Be Immediate.**—The One-stage Operation is here performed; _ This may be performed in one of two ways: _ The peritoneal surface of the spleen is sutured with catgut to the parietal peritoneum, at the margin of the abdominal opening – the sutures not entering the abscess. The abscess cavity is then emptied and drained. In emptying the abscess it is safer to largely accomplish this, first, by aspiratory syringe, and then, when the abscess cavity is under no tension, to incise and drain it – thus doing away with the gush of pus that occurs in incising under tension. Or the abscess may be first incised, after protecting the neighborhood with gauze, and its margins then sutured to the margins of the wound of exposure, and drainage established.

(*c*) **If the Spleen Be Non-adherent at the Site of Exposure – and No Need for Immediate Incision of the Abscess Be Present.**—The Two-stage Operation is then usually performed. This is best accomplished by suturing the surface of the spleen to the margin of the abdominal opening, followed by packing the wound with gauze for two or three days. Sometimes the gauze is simply packed through the wound, down upon the spleen, without suturing to the wound – and time given for the shutting off of the general peritoneal cavity, and for adhesion of the spleen to the abdominal wall to occur. When adhesions are firm, and the peritoneum is shut off, the abscess is incised – and drained.

When the spleen has been incised for exploration simply, and nothing has been found, splenorrhaphy is done, and the abdomen closed.

In all cases the abdominal wound is sutured up to the site of drainage – especially repairing, by suture, as well as possible, all incised musculature.

Comments.—In suturing the spleen to the abdominal wall the sutures of catgut pass through the splenic substance and capsule at some distance from the wound in the viscus (either already made or to be made), on the one hand, and through the parietal peritoneum and part of the thickness of the lower plane of the lips of the abdominal wound, on the other – thus approximating the peritoneum of the spleen and the peritoneum of the abdominal wall all around – but carefully avoiding the penetration of the abscess cavity.

In incising the spleen the cut is made, as far as it is possible to determine and circumstances will allow, so as to avoid the larger splenic vessels.

The above method of marsupialization is also applicable to hydatid cysts of the spleen, but often proves tedious because of the length of time involved in the cure.

It often happens that the site of splenic involvement is in the upper aspect of the spleen rather than the lower – so that a simple subcostal incision will not expose the site of lesion. In such cases the field is best exposed by the partial excision of the last rib or two – or, better, by a composite flap of the lower costal arch, temporarily raised. In these latter instances the approach may be made directly through the pleura, if adherent – or through the pleura after suturing together the parietal and visceral layers (which are more or less in contact in this region) to the diaphragm – or sometimes the pleura may be pushed up from the spleen, and the spleen be incised below it – (as in the corresponding operations upon the liver, pp. 444–447 and pp. 451–454).

The spleen is sometimes exposed in an intercostal space – this approach furnishing, however, but little room for manipulation.

If, in incising the spleen, profuse bleeding occurs, this may usually be controlled by plugging the incision wound with strips of gauze. The plugging is made easier if the spleen is held by adhesions, so as not to recede in the act of plugging.

In approaching the upper pole of the spleen part of the ninth, tenth, or eleventh ribs are excised in the postaxillary line – and the spleen incised through the diaphragm.

The retroperitoneal exposure of the spleen has been used _ but is not desirable. Part of the twelfth and sometimes part of the eleventh ribs are excised _ and the lower surface of the diaphragm is followed upward with the finger until the spleen is reached.

Exposure of the Spleen By the Subpleural Route _ By the Partial Excision of One or Two Ribs.—For the general description see the corresponding operation upon the liver. The ribs chosen are usually the tenth and eleventh (and the former when only one rib is excised) _ the site of excision lying midway between a point about 4 to 5 cm. ($1\frac{1}{2}$–2 inches) from the median plane, and a point just posterior to the midaxillary line. The steps of the operation are the same as those for the subpleural exposure of the liver by the partial excision of one or more ribs (see page 451).

OPERATIVE TREATMENT OF WOUNDS OF THE SPLEEN

The wounds of the spleen encountered are: contused, gunshot, punctured, incised, lacerated, penetrating, and rupturing. Owing to the vascularity of the organ, hemorrhage is the chief feature to be met in the majority of cases _ outside of the most destructive traumatisms, in which other considerations, in addition, enter. If the splenic artery or vein be wounded, life is usually lost before relief can be given.

The method of exposing the spleen will be determined by the position and nature of the wound. The method best suited to the individual case is chosen _ and the wounded organ exposed and brought into the field as well as possible.

The paramount feature common to all wounds of the spleen proper is to ascertain whether serious bleeding is taking place, and, if so, to control it by ligature of individual vessels with catgut _ by mass ligature of the limited region from which ill-defined bleeding is occurring _ or by clamping the site of hemorrhage temporarily (even sometimes bringing the clamp or clamps out through the wound, in the dressing) _ or by gauze packing, the end of the gauze strip emerging from the wound. The next most important feature is the removal, as far as possible, of sources of infection connected with the wounding object. Associated wounds of adjacent organs and structures must, of course, be met according to their special indications. It is nearly always indicated, and it is safer, to temporarily conduct a drain from the wounded surface out through the abdominal wall.

Punctured and incised wounds, of limited extent, without hemorrhage, and comparatively cleanly made, may be sutured with catgut stitches. If hemorrhage be present, effort should be made to definitely ligate bleeding vessels.

Lacerating and rupturing wounds often present difficult problems. The measures above described should be resorted to to control bleeding. Deeply placed mattress-sutures will sometimes control bleeding when ordinary suturing will not. They should be placed at some distance from the margins of the wound. It is especially in these cases that drainage is indicated. When the spleen is exposed the bleeding may be so active that the only available step is to temporarily clamp the pedicle with rubber-covered clamps until the torn vessels can be found and ligated. This may sometimes be accomplished, so that when the clamps are relaxed the vessels will be found controlled. At other times the only course open is to excise the spleen.

Gunshot wounds may present the features of a penetrating puncture or of an extensive laceration, and require corresponding treatment. Other organs are much more apt to be also injured in the case of gunshot wounds.

The capsule of the spleen may be limitedly or extensively torn _ and require suturing.

Senn crushed the bleeding margins of the wounded spleen with broad forcipressure forceps _ and then sutured these margins together _ with satisfactory result.

Comments.—If the wound do not lead to the adoption of a special method of exposure, the subcostal oblique incision or vertical incision in the left linea semilunaris may be chosen. See Wounds of the Liver, p. 454.

SPLENORRHAPHY

Description.—Suturing of the spleen is resorted to for wounds of the organ, and for approximating surfaces after partial splenectomy.

The route of approach in generally determined by a pre-existing wound, or by the operation planned for the major procedure. If not, the oblique subcostal incision, parallel with the left costal arch, gives satisfactory exposure.

The details of various methods of suturing, in the case of corresponding conditions of the liver, are given later (pp. 456–457) _ and apply, equally, to the spleen _ the technical procedure being the same in both.

METHODS OF SPLENOPEXY FOR SPLENOPTOSIS

Description.—The fixation (splenopexy) of a "wandering spleen" (splenoptosis) is often indicated in cases where the spleen is otherwise practically normal, but is markedly abnormal in its degree of freedom and mobility. Splenoptosis, however, is generally associated with other conditions apart from mere mobility _ such as enlargement of the organ; torsion of the elongated pedicle, causing recurrences of acute congestions, or the establishment of chronic congestion, apart from the immediate danger to the blood-supply; thrombosis of the pedicular vessels; splenic infarction, and the like. In these latter cases splenectomy rather than splenopexy is indicated.

Splenopexy, as formerly performed, consisted in suturing the spleen to the parietal peritoneum. This method alone is no longer considered sufficient. More secure anchorage is sought _ and is generally attained by some form of "pocketing." Several technical procedures have been worked out.

Preparation _ Position _ Landmarks.—As for Partial or Total Splenectomy.

Incision.—This will depend upon the method of fixation employed _ and will be stated under the individual procedure.

Splenopexy by the Rydigier Method.—The spleen is exposed by median abdominal section (as originally carried out by Rydigier) _ or by a vertical incision through the outer border of the sheath of the left rectus muscle _ and its lower pole is placed within an artificially formed peritoneal pouch, hammock fashion. Having opened the abdomen, exposed and isolated the displaced spleen, and examined its environments and the laxity of its ligaments, as well as the neighboring diaphragmatic wall, the site for its fixation is decided upon. On a level with the lower part of the left ninth intercostal space, or of the tenth rib, a transverse incision, with slight upward convexity, is made through the peritoneum covering the inferior aspect of the diaphragm, through the peritoneum only _ its transverse extent being very nearly as great as the anteroposterior diameter of the spleen (Fig. 3625). The lower lip of the peritoneum is then seized with clamp-forceps and drawn slightly away from the abdominal parietes, while the Surgeon bluntly dissects the parietal peritoneum away from the muscular and costal parietes _ until a hammock-like pocket is formed large enough to hold the lower pole of the spleen. The outer wall of this pocket will be formed by diaphragm, intercostal muscles, and ribs – and the inner wall by parietal peritoneum alone. To keep the parietal peritoneum of the pocket from further separating from the abdominal wall, a curvilinear line of suturing is carried around its lower aspect. The spleen is then elevated upon its pedicle and its lower half is bodily placed within the prepared pocket – its pedicle resting upon the upper border of the detached lower peritoneal leaf (Fig. 3626) – with the outer aspect of the spleen in contact with the inner aspect of the abdominal wall. The spleen should fit somewhat snugly within its pocket, but not be strangulated. By slightly compressing the splenic substance between the fingers of one hand, while practising slight traction upon the mouth of the pocket with a blunt-hook in the other hand, the spleen can be gently forced into its pocket. To further secure it within its new position, an interrupted suture may be made to slightly narrow the pocket at its anterior end, while another suture may anchor, while narrowing, the posterior end to some non-vascular part of the splenic pedicle. The position of the spleen may be further safeguarded by stitching the free border of the peritoneal pocket to the gastrosplenic omentum. Avoid having sutures penetrate the substance of the spleen on account of the

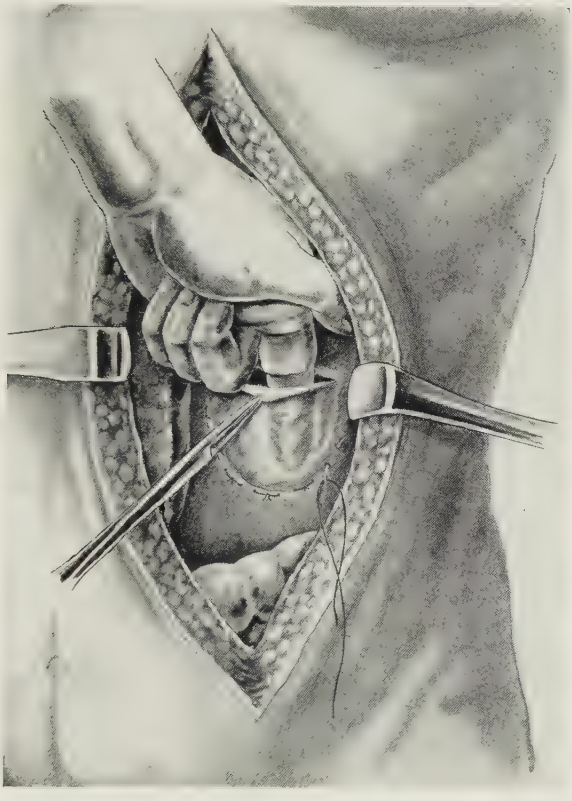


Fig. 3625.—Splenopexy by the Rydigier Method – I; – The parietal peritoneum has been excised to form a pocket for the lower pole of the spleen – and is being deepened by the finger. A continuous suture is being placed to prevent the too great separation of the parietal peritoneum from the abdominal wall.

likelihood of hemorrhage. The abdomen is closed without drainage _ unless indicated by some unusual circumstances.

Splenopexy by the Bardenheuer Method.—The spleen is exposed by an incision in the left axillary line _ and, working from without, a pocket is formed between the peritoneum and the abdominal wall, for the entire spleen, instead of just the lower pole. The patient lying upon his right side, a straight incision is made in the left axillary line, extending from the tenth rib to the iliac crest _ and from the upper end of this incision a second incision is extended forward along the lower border of the tenth rib. The soft parts are incised through down to, but not into, the peritoneum _ after which the peritoneum is raised from the parietal wall by blunt dissection with the finger, introduced through the wound from without, over an area somewhat larger than the spleen to be accommodated _ the margins of the triangular flap of soft parts being displaced inward and downward, as far as may be necessary for manipulation. A transverse incision is then made in the center of the detached peritoneum. Through the incision thus made, the condition of the spleen and its surroundings are examined. If all be propitious for the operation, and guided by the left index-finger within this opening, by means of

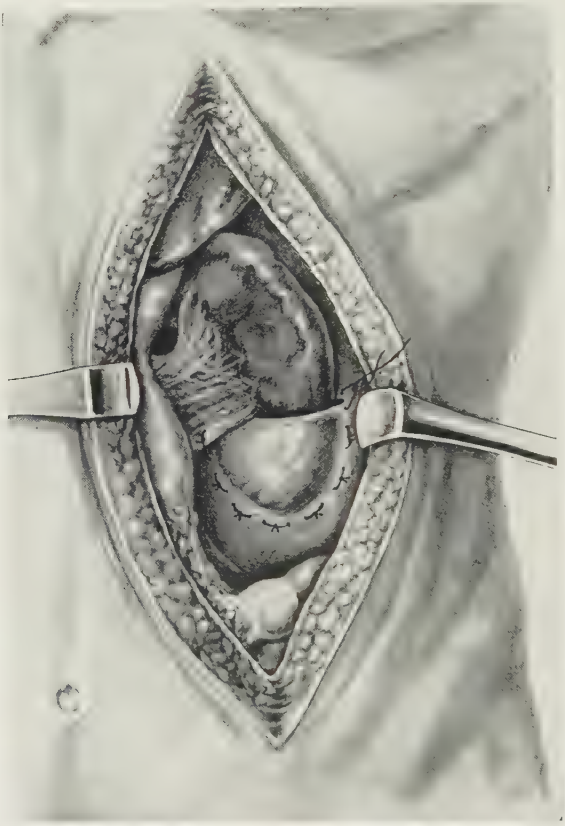


Fig. 3626.—The Same _ II; _ The lower pole of the spleen has been placed within its supporting pocket, and the length of the pocket opening somewhat lessened by an additional stitch at the ends, the inner one including a non-vascular part of the pedicular structures.

which the viscera can, at the same time, be pushed out of the way, a continuous purse-string suture, in oval contour, of fairly heavy chromic catgut, is carried _ the oval of the suture being smaller than the spleen. The free ends of the purse-string suture are temporarily clamped _ while the Surgeon introduces the fingers of his right hand through the slit in the peritoneum, seizes the spleen, and draws it, edgewise, through the peritoneal opening, into the space between the peritoneum and parietal wall from which the peritoneum has been detached. After this the oval draw-string is tightened just enough to gather up and pucker the loosened peritoneum around the pedicle of the spleen in its new extraperitoneal bed, but not constricting it. The parietal wound is closed without drainage.

Other Methods of Splenopexy:

Tuffier sutured the spleen to the diaphragm, or to the abdominal wall.

Greiffenhagen carried two heavy silk sutures through the abdominal wall and spleen _ which was followed by dangerous hemorrhage.

Kouwer held the spleen in position by means of gauze packing, until multiple adhesions fixed the spleen in its new position.

Schiassi made a vertical incision 15 to 20 cm. (6–8 inches) in length, which was extended to the right, parallel with the left costal arch. The omentum (presumably gastrosplenic omentum) was then sutured to the upper and lateral edges of the rectangular flap.

After-treatment of Splenopexy Cases.—Confinement to bed should continue for three or four weeks _ preferably, or chiefly, on the left side _ and with the foot of the bed elevated.

PARTIAL SPLENECTOMY

BY SUBCOSTAL INCISION PARALLEL WITH RIBS

Description.—Excision of part of spleen. Generally done for removal of tumor involving a portion of the organ _ usually, non-parasitic, pediculated cysts.

Preparation _ Position.—As for Total Splenectomy.

Landmarks.—Lower border of left costal arch _ or modified by the position of a tumor, if one be present.

Incision.—Oblique incision, parallel with and about 1.2 cm. ($\frac{1}{2}$ inch) below the left costal arch, with its center over the site of the spleen (whose inner border extends to within 4 or 5 cm. [$1\frac{1}{2}$ or 2 inches] of the median plane, and whose outer border extends just posteriorly to the midaxillary line), _ or, if a tumor be present, directly over the tumor.

Operation.—Having incised the skin and fascia; the external oblique transversely; separated the internal oblique in the cleavage line; retracted what nerves could be spared; divided the transversalis obliquely; and the transversalis fascia, subserous areolar tissue, and peritoneum in the line of the original wound, the abdominal cavity is opened. Having retracted the wound and brought the spleen as far into the opening as possible, the area of the spleen to be removed, including the tumor, if any, is now to be surrounded in sections by interlocking silk or chromic gut ligatures and tightened _ or other form of ligature which will compress the entire area to be circumscribed and removed. When the entire portion to be removed has been thus circumscribed by a compressing ligature, the tied off area is excised with curved scissors, or by the actual cautery _ further ligating any portions requiring ligature. Where the area to be removed has any ligamentous attachments corresponding to it, or adhesions connected with it, these are first tied off and divided between ligatures. Where possible, the surfaces left by the partial excision, which should be wedge shaped, if possible, should be approximated by deeply placed sutures. (See Splenorrhaphy, page 424.) The spleen is then dropped back into place and the abdomen generally closed without drainage.

Comment.—Where the tumor or tumors are small, small wedge-shaped masses may be removed and the edges approximated by deeply placed sutures, which both coapt the surfaces and control the hemorrhage thus obviating any previous ligation of the spleen substance.

TOTAL SPLENECTOMY

The functions of the spleen are not known with absolute definiteness and in their entirety but it is known that patients generally tolerate, without evidences of serious embarrassment, the removal of a very much diseased or injured spleen although the full and exact effect ultimately exercised upon his physical economy is unknown. The probability is that the removal of a considerably diseased spleen is better borne than would be the case in the loss of a normal spleen time having been given for the partial assumption of compensatory functions by other structures.

Indications for the Total Removal of the Spleen.—Extensive, or disorganizing injuries of the organ; traumatic hernia; very movable, non-diseased spleen, which has failed to be held by operative or other measures, or unlikely to be held by them; less movable, but simultaneously diseased spleen; twisted pedicle; tumors; spontaneous rupture; aneurysm of the splenic artery (Winckler); abscess; tubercular disease; cysts (hydatid, non-parasitic, and dermoid); enlarged spleen, from malaria; enlarged spleen, from simple hypertrophy; enlarged spleen, from Banti's disease (splenic anemia). Three other indications are given by Bland-Sutton; certain cases of splenic enlargement associated with hemolytic anemia and acholuric jaundice; certain cases of blood-vomiting associated with engorgement of the gastric and splenic veins as a result of obstruction of the portal vein; possibly certain cases of splenic enlargement resulting from portal vein obstruction.

Contraindications to Splenectomy.—Leukemia; general tuberculosis, and in syphilis; erythemia; dense and complicating adhesions; the portal hepatic cirrhosis occurring in connection with enlargement of the spleen, gastro-intestinal hemorrhage, and ascites, which is sometimes mistaken for splenic anemia.

Preparation.—As for abdominal section.

Position.—Flatly upon the back, for the more median incisions of approach, and slightly tilted to the opposite side, for the more lateral incisions.

Landmarks.—Linea media; left linea semilunaris; left costal arch; the position of the spleen (v. Surface Form and Landmarks, p. 420). The use of these will depend upon the method of approach adopted.

Incisions of Approach.—The following methods of approach have been employed in exposing the spleen for removal (Fig. 3605): (*a*) Median abdominal section, beginning below the ensiform cartilage and extending as far below the umbilicus as the case requires; (*b*) Oblique, parallel incision, about 1.3 cm. ($\frac{1}{2}$ inch) below the left costal arch; (*c*) Vertical incision in the left linea semilunaris, or in the outer margin of the left rectus muscle, with inward extension of the incision below and parallel with the left costal arch (left-sided Bevan or Mayo incision); (*d*) Vertical incision over the outer border of the left rectus muscle, with an extension of its upper end (if more room be necessary) upward and backward, in the eighth intercostal space, with excision of the cartilages of the eighth, ninth, and tenth ribs (Auvray's incision); _ (*e*) Vertical incision, beginning at the cartilage of the left seventh rib and extending downward to the level of the umbilicus, with excision of a part of each rib (Doyen's incision); _ (*f*) Parallel subcostal incision, with resection of eighth, ninth, and tenth costal cartilages. A regrettable feature of all the vertical incisions is the damage done to the nerve supply of the parts. The intra-abdominal manipulations, as far as the technical details of dealing with the spleen are concerned, are practically the same, irrespective of the method of exposure. The choice of the method will depend upon the size of the spleen and the judgment of the Surgeon.

Operation.—The removal of the spleen, in the average case, is a relatively simple procedure _ whereas, its removal in the presence of complicating adhesions may be so beset with difficulties and dangers as to be unaccomplishable.

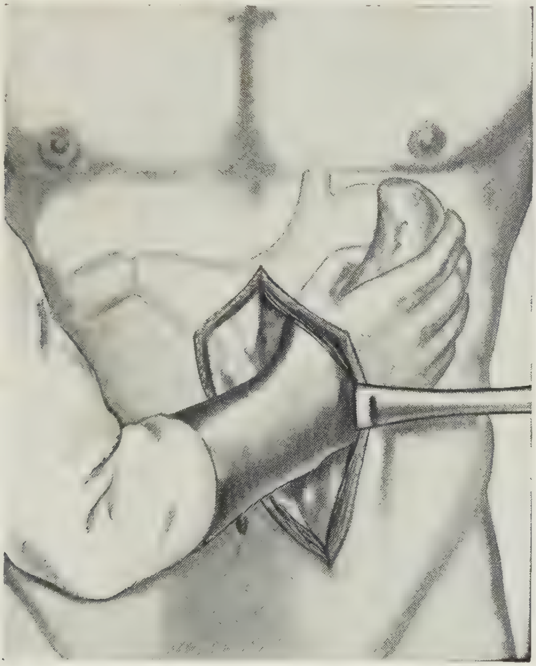


Fig. 3627.—Total Splenectomy: _ The introduction of the hand into the abdominal cavity for the purpose of separating adhesions and delivering the spleen into the abdominal wound.

Having opened the abdomen and retracted the wound margins by, for illustration, the left-sided Bevan incision, the Surgeon inserts his right hand into the peritoneal cavity and makes a thorough examination, first of the spleen (Fig. 3627), and its immediate surroundings, especially with reference to the presence, extent and nature of its adhesions _ and as to the condition of the stomach and gall-bladder tract. Mental summary is made of the result of this manual examination, and if not too dense adhesions be found, the freeing of these by blunt finger-dissection is systematically undertaken. The upper pole is first freed _ and then the outer surface of the organ _ the fingers of the right hand working between the diaphragm and the spleen, with the pulps of the fingers toward the latter. Hemorrhage at this stage may be considerable and difficult to control, because of the field being out of view. Adhesions too dense to be torn through by the fingers are grasped with double curved clamps, and divided by curved scissors between these clamps. Bleeding at this step, while the spleen is still in normal *situ*, may often be controlled by hot packs – which, together with division of adhesions between clamps, represent the most dependable measures at the command of the Surgeon, in this stage. Having freed the upper pole and the outer surface, the lower pole of the spleen is displaced upward, and the lineorenal ligament, together with its vessels, is divided between two ligatures. The gastrosplenic omentum, which conveys the vasa brevia vessels, is also divided between two previously placed ligatures – and in doing this, care is to be exercised that the end of the stomach is not cut, as it lies in very close relationship.

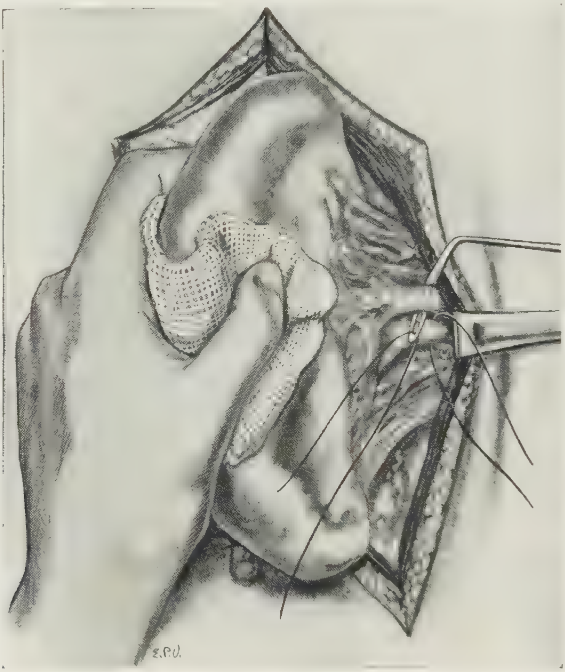


Fig. 3628.—Ligation of the Individual Vessels of the Splenic Pedicle, without Previous Clamping; – The spleen has here been delivered from the wound and displaced mediad, thereby exposing the posterior aspect of the pedicle.

The spleen now stands freed of its ligamentous attachments – held only by its pedicle. The mobilized organ is then delivered through the abdominal wound – being turned inward and outward by the following maneuver: – The inner margin of the abdominal wound is depressed by the Surgeon's left hand – while his right hand, with palm to spleen, is applied over the upper pole and outer surface (an Assistant steadying the lower pole) revolves the spleen upon its pedicle, as an axis – turning it inward and outward through the abdominal wound, upon its own pedicle as an axis. It is necessary to use care in delivering the spleen out into the abdominal wound, lest the vascular structures of the pedicle be ruptured in the act, which is more apt to occur – and this is chiefly accomplished by carefulness of manipulation, and full support of the heavy organ.

Ligation of the pedicle of the spleen is now carried out – which is sometimes accomplished readily, sometimes with difficulty, but which, with the separation of adhesions, constitutes one of the two most important steps of the operation. Three methods of ligating the splenic pedicle are in vogue: – (*a*) Ligation of the individual vessels, without previous clamping (Fig. 3628) – the most desirable method, and usually available when the pedicle is fairly long. As the spleen is displaced mediad upon its own pedicle as an axis the aspect of the vascular pedicle which, normally, was posterior is caused to present anteriad, or, more properly, anteriorly and to the left. The peritoneum is first divided over the splenic artery (or the one or two splenic arteries) and the vessels freed as for an ordinary ligation, for the space of 2 or 3 cm. (an inch or more), and tied by proximal and distal ligatures, tying the distal ligature closely to the spleen – after which the vessel is divided, nearer to the spleen than otherwise, so as to leave a long, safe stump. The two or more splenic veins are similarly exposed and ligated. The pedicle is then divided distally to the ligatures – and any secondary vessels which may bleed are separately taken up and tied. (*b*) Segmental ligation of the pedicular vessels and connective tissue in segments, after previous clamping (Fig. 3629); – this is probably the most usually adopted method if the pedicle be of moderate length. A rubber-covered clamp is applied to the vascular pedicle at a distance of about 7.5 cm. (3 inches) from the spleen, if possible, firmly enough to control but not to crush the vessels. The extent of pedicle, including its vessels, is then divided into segments – by pushing a pair of hemostat forceps through non-vascular portions, and drawing a series of loop-ligatures through. The limbs of these ligatures are then crossed and tied in pairs, so as to interlock with each other – forming a series of interlocking ligatures entirely across

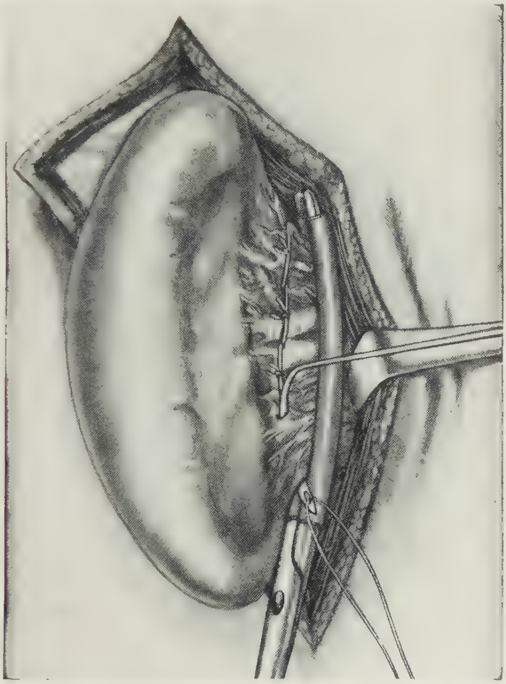


Fig. 3629.—Segmental Ligation of the Splenic Pedicle, after Previous Clamping.

the pedicle _ which is then divided distally to the ligatures, and the clamp released. If even greater security be deemed necessary, a mass ligature may be additionally thrown around the entire pedicle. (*c*) Mass ligature of the pedicle, after clamp control (Fig. 3630); _ This is often the only available method when the splenic pedicle is so short that the pedicle cannot be exposed for individual ligation of the vessels, or even segmental ligation of the pedicle. Two curved or angular rubber-protected clamps are made to seize the splenic pedicle at least 2 cm. ($\frac{3}{4}$ inch) apart, and further if possible _ after which the pedicle is divided between the distal clamp and the spleen (rather nearer the latter). A gush of blood will come from the blood-filled spleen, by back-flow, which may be temporarily discomforting and soiling. A stout pedicle ligature is then thrown around the splenic pedicle, between the two clamps, and at first only lightly looped. The proximal clamp is then released _ and the loose ligature slipped immediately into its place and tightened, and doubly knotted. It is sought to have this ligature placed far enough from the distal clamp to enable the parts to be thoroughly compressed by the tightened ligature _ but if there be any doubt on this score when the distal clamp is relaxed, a second ligature may be applied.

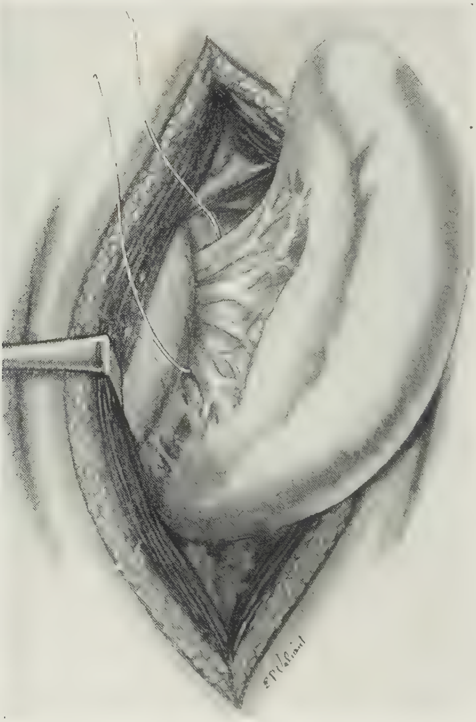


Fig. 3630.—The Same _ V; _ Mass ligature of the splenic pedicle.

At all times should care be used, but it should be especially used in ligating a short pedicle _ to see that the cardiac end of the stomach and the tail of the pancreas are not included in the ligature. If either be temporarily included in the clasp of rubber-covered clamps, they are not generally injured.

A final survey should be made of the ligated pedicle, and any minor vessels found bleeding should be separately tied with finer catgut. Sometimes the free margin of the ligated pedicle is whipped over with a catgut ligature _ or covered with omentum.

The spleen is now entirely free _ and is removed from the abdomen _ and the hot-packs slowly withdrawn. Finally, one surveys the field of separated adhesions to see that no bleeding is taking place. Any vessels, or sites, from which hemorrhage is occurring, are ligated individually or *en masse*.

Mayo lays stress upon the closure of the splenic space, by what he terms a "snaking suture," which he describes as follows (Fig. 3631): _ "With catgut on a small curved needle, the raw space beginning at the tied splenic vessels is closed as well as possible. The margin of the lineorenal ligament, on the outer side, is sufficiently firm to hold a suture, but on the inner side such bits of tissue must be caught here and there as can be done safely, until the bleeding vessels are compressed. The last suture comes well down in the diaphragm and had best be applied during cardiac diastole and during expiration."

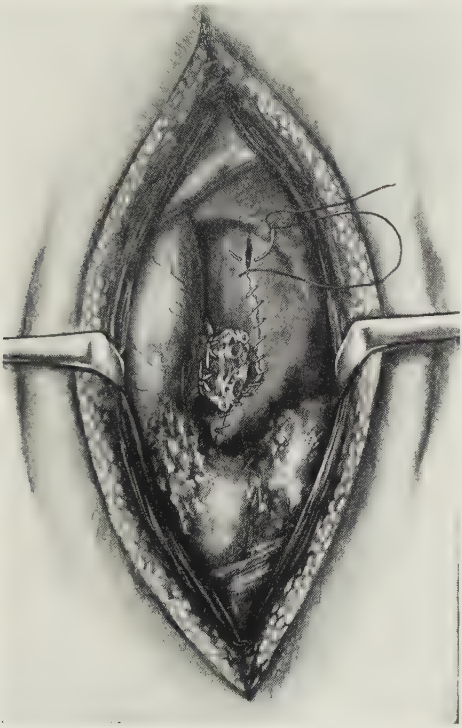


Fig. 3631.—The Same _ VI; _ Suturing the bed of the excised spleen to control hemorrhage from the exposed tissues.

If the wound be absolutely dry, and no soiling of the peritoneum have taken place, the abdomen is closed without drainage. If the reverse obtains, temporary drainage is safer.

Comments.—It is to be remembered that bleeding is the chief source of danger in splenectomy _ that the vessels of the pedicle, especially the veins, are very friable _ that the spleen substance may bleed freely from a torn capsule _ that the splenic vessels bleed from both ends _ and that adhesions may bleed profusely.

Finkelstein performed, personally, 66 splenectomies, from 1903 to 1913, with 38 per cent. mortality. Carstens presented a collection of 739 splenectomies, with 27.4 per cent. mortality.

In delivering the spleen through the abdominal wound in exposing the pedicle for ligature the fundus of the stomach, as well as the transverse colon and the lienophrenic ligament, generally also come with it _ so that some of the separations and ligations can often be carried on out in the open.

The tail of the pancreas has been tied in with the ligation of the pedicle. No harm followed this mishap in 3 cases mentioned by William J. Mayo _ who found that the temporarily used drain introduced in consequence, in due care had proved unneeded.

Mayo states the estimated mortality for splenectomy to be from 18.5 to 27.5 per cent. _ and that if the patient be in fair condition, should range from 5 to 10 per cent.

When the blunt dissection of adhesions causes more than such a grade of oozing as can be controlled by pressure, the bands of adhesion should be divided between ligatures.

If at any stage of manipulation violent bleeding occurs from the pedicle, this should be clamped _ or quickly ligated, *en masse*, and while the pedicle is in relaxation.

After ligating *en masse*, or even after ligating in segments, if it be deemed desirable the larger vessels may be individually exposed in the pedicle, proximal to the first ligaturing, and separately tied.

In ligaturing the pedicle *en masse*, in segments, or by individual vessels stout chromic catgut, Pagenstecher, or silk may be employed.

Shock sometimes occurs in tying off the pedicle, as a result of irritating nerves from the solar plexus.

The spleen may shrink considerably in size during ligation of the pedicle. And while, theoretically, it is indicated to tie the arteries first, practically, it makes no difference whether veins or arteries are first ligated.

If more room be required, the costal cartilages of the left eighth, ninth, and tenth ribs are resected. Other incisions may be made as extensions to the original incision, as given under Incisions, p. 428.

The phrenosplenic ligament is best reached and freed, as suggested by Jonnesco, by covering the spleen with a square of gauze to avoid slipping of fingers, and then depressing the spleen downward and to the right, while an Assistant draws the left lower edge of the abdominal wound to the left _ thus exposing the bed of the spleen and vault of the diaphragm and the phrenosplenic ligament, which latter is divided between double ligatures. Following this the remaining ligaments and attachments of the spleen to its bed are freed, commencing at its lower aspect. The spleen is then enucleated and delivered through the abdominal wound. The gastrosplenic ligament is the omentum surrounding the pedicle, and therefore a part of the pedicle _ and is treated in ligating the pedicle.

The spleen having been delivered, is then turned toward its left and made to rest upon its convexity, thus exposing its pedicle. The constituent vessels of the pedicle, beginning with the most important, should all be separated and each doubly ligated and divided between the two ligatures. This is the most important step of the operation. Separate ligation is better than ligation *en masse*, or in two or three divisions or groups of vessels _ though the latter may be done in cases of haste or other need. Traction upon the constituents of the pedicle, which are easily ruptured, is to be avoided. Adherence of the splenic artery and vein to the tail of the pancreas often adds to the difficulty of isolation and separate ligature of these vessels. Having removed the spleen, its bed is carefully examined — and every bleeding point ligated with chromic gut. Especially examine the pillar of the diaphragm, where the phrenosplenic ligament has been divided — after drawing the stomach and intestines to the right. Limited bleeding surfaces may be controlled by suturing peritoneum over them, where possible. See that ligatures, in tying off the pedicle, pass between rather than through the vessels — passing through connective tissue between the vessels. After exposing the spleen the hand should be passed between it and the diaphragm and its surface examined — as well as its other aspects, as far as possible. Very extensive and firm adhesions would contraindicate the continuance of the operation. Practice no traction upon the pedicle, both because of the friable vessels and because of the general bad symptoms which are apt to supervene from pressure upon the splenic plexus (from the solar plexus). Relax the pedicle before tightening each ligature. Treatment of the pedicle comes first in importance and treatment of adhesions second. Hemorrhage is the chief danger. If secondary hemorrhage be feared, suture the pedicle to the abdominal wall.

CHAPTER LXIX

OPERATIONS UPON THE LIVER APART FROM THE GALL-BLADDER AND THE BILIARY DUCTS

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SURGICAL ANATOMY OF THE LIVER

Description.—Presents three surfaces (superior, or phrenic; _ inferior, or visceral; _ posterior): _ two extremities (right and left): _ one border (anterior). Its average measurements are transversely, 28 cm. (11 inches) _ anteroposteriorly, 20 cm. (8 inches) _ vertically, 6 cm. (2½ inches).

Position.—Occupies parts of right hypochondriac, epigastric, and left hypochondriac regions; _ situated below diaphragm _ above stomach, duodenum, transverse colon, and small intestine _ and in front of right false ribs (tenth, eleventh, and twelfth).

Fissures.—**Left longitudinal fissure:** _ Anterior part forms umbilical fissure (for umbilical vein in fetus, and for its remains, the round ligament, in adult); _ Posterior part forms fissure of ductus venosus. **Right longitudinal fissure:** _ Anterior part, forms fossa for gall-bladder; _ Posterior part, fossa for vena cava. **Transverse fissure:** _ Transmits hepatic artery, portal vein, hepatic duct, nerves, lymphatics, and connective tissue.

Lobes.—Right, Left, Quadrate, Caudate, Spigelian.

Ligaments and Fixations of Liver.—(1) **Coronary:** _ from posterior surface of liver to diaphragm. Formed of two layers of reflected parietal peritoneum. (2) **Right lateral ligament:** _ from right lobe of liver to back of diaphragm. Lateral continuation of coronary ligament. (3) **Left lateral ligament:** _ from left lobe of liver to diaphragm anterior to esophagus. Lateral continuation of coronary ligament. *Note:*—Middle portion of coronary ligament has its anterior layer furnished by greater peritoneal sac, its posterior layer by lesser sac; Right lateral ligament has both layers from greater sac; Left lateral ligament has both layers from greater sac. (4) **Longitudinal (broad or suspensory) ligament:** _ Passes anteroposteriorly upon upper and anterior portion of liver. Posteriorly and superiorly it is connected with the coronary ligament. Anteriorly and superiorly it is connected with the posterior sheath of the right rectus muscle, up to the umbilicus _ and thence to under surface of diaphragm, diverging to either side. Free anterior margin extends from interlobular notch to transverse fissure _ containing round ligament (remains of fetal umbilical vein). Inferiorly it extends along the superior surface of the liver from before backward. Formed by portions of peritoneum covering superior surface of liver _ one layer passing over left lobe, the other over right, and meeting at longitudinal ligament. (5) **Round ligament:**—Remains of umbilical vein _ in free margin of longitudinal ligament, extending from left longitudinal fissure to umbilicus. (6) **Lesser omentum** (**Gastrohepatic omentum**): _ may be considered a ligament of liver, consisting of following parts: _ (**a**) Lig. Hepatogastricum _ from borders of transverse fissure to upper curvature of stomach; _ (**b**) Lig. Hepatoduodenale _ that part embracing superior curvature of duodenum, and enclosing following structures: common bile-duct, portal vein, hepatic artery, lymphatics, and nerves; _ (**c**) Lig. Hepatocolicum _ that part passing over duodenum to transverse colon; _ (**d**) Lig. Hepatorenale _ that part from inferior surface of right lobe of liver (near gall-bladder and vena cava, and posterior to foramen of Winslow), to upper surface of right kidney; _ (**e**) Lig. Cysticodudoenale _ that part from gall-bladder to duodenum. *Note:*—Fusion of upper surface of liver to diaphragm forms a strong fixation of liver.

Peritoneal Covering.—Only portions of liver uncovered by peritoneum are: transverse fissure, fossa of gall-bladder, and posterosuperior aspect of right lobe (where fused to diaphragm).

Relations.—(1) **Anteroposteriorly:** _ diaphragm (whole of right arch and part of left _ which separates liver from right and left lungs and pericardium); abdominal wall; six or seven lower right ribs (seventh to eleventh, according to Morris); fifth to ninth right costal cartilages (sixth to ninth, according to Morris). (2) **Inferiorly:**—stomach (cardiac and pyloric ends, lesser curvature, and part of anterior surface); duodenum (superior curve and descending parts); gall-bladder and cystic duct; portal vessels; right kidney and capsule; colon (hepatic flexion). (3) **Posteriorly:**—diaphragm and crura; tenth and eleventh dorsal vertebræ; tenth and eleventh ribs; esophagus; aorta; vena cava; right suprarenal capsule; thoracic duct.

Vessels of Liver.—Hepatic artery (of celiac axis), artery of supply; Portal vein, bringing blood from stomach, intestines, pancreas, and spleen; Hepatic veins, emptying blood of liver into vena cava; Hepatic duct, formed at transverse fissure.

Lymphatics.—Deep set; accompany portal vein, hepatic artery, and duct and join superficial set. Superficial set; empty into (**a**) mediastinal glands; (**b**) sometimes into thoracic duct; (**c**) glands of small omentum; (**d**) lumbar glands; (**e**) glands of esophagus and lesser curvature of stomach.

Nerves.—From left pneumogastric and celiac plexus.

Structures at Transverse Fissure.—(a) Hepatic artery, portal vein, and numerous nerves enter: _ (b) Hepatic duct and some lymphatics leave. *Note:* The hepatic veins do not emerge here, but pass backward into the vena cava.

Order of Structures at Transverse Fissure.—From before backward; hepatic duct, hepatic artery, portal vein.

Order of Structures in Gastrohepatic Omentum.—Common bile-duct, to right; hepatic artery, to left; portal vein, behind and between other two.

SURFACE FORM AND LANDMARKS

The liver occupies parts of the right hypochondriac, epigastric, and left hypochondriac regions _ filling all of the right and part of the left diaphragmatic arches _ the diaphragm forming the dome of the cavity in which the liver rests and passing down laterally between the ribs and liver.

Upper limit of right lobe _ lies along the line from the right fifth chondrosternal articulation extending horizontally outward to a point about 2.5 cm. (1 inch) below the right nipple _ thence downward to the seventh rib at the lateral aspect of chest.

Upper limit of left lobe _ lies along the line from the right fifth chondrosternal articulation, extending across the sternum slightly downward to a point about 5 cm. (2 inches) to the left of the gladiolus, on a level with the left sixth costal cartilage.

Lower limit of right margin _ corresponds with a line passing from behind forward, about 1.2 cm. ($\frac{1}{2}$ inch) below the lower margin of the right thorax to right ninth costal cartilage _ thence obliquely across the subcostal angle to the left eighth costal cartilage.

Lower limit of left margin _ represented by a curved line, with outward convexity, from the left eighth costal cartilage to a point 5 cm. (2 inches) to the left of the gladiolus and on a level with the left sixth costal cartilage.

Lower border of liver in middle line _ about half-way between the xiphoid cartilage and umbilicus.

Convex surface of liver, on right side _ corresponds with the seventh to eleventh ribs, inclusive _ and, in front, with the ensiform cartilage and sixth to ninth costal cartilages, inclusive.

Heart descends to the left fifth interspace. Right lung descends to the superior margin of the sixth rib, in the nipple line.

Note.—Authorities differ considerably upon the relations of the liver to the thoracic wall

GENERAL SURGICAL CONSIDERATIONS

The liver may be approached either through the abdominal cavity, the more usual route — constituting a transperitoneal operation; — or through the thoracic cavity — in which latter case the operation may be either transpleural or subpleural. The liver may also be approached posteriorly where covered by neither pleura nor peritoneum.

While desirable that all incisions should be in intramuscular cleavage lines as far as possible, yet, as hernia of the upper abdominal wall is less frequent than of the lower, incisions about the liver and gall-bladder, therefore, often violate this desirable rule.

The two most general methods of transperitoneal approach are the following: — (**a**) By incision parallel with and about 1.2 to 2 cm. ($\frac{1}{2}$–$\frac{3}{4}$ inch) below the right costal arch, with its center over the indicated site; — (**b**) By vertical incision over some part of the right rectus — or in the right linea semilunaris (which runs down from the ninth rib to the pubic spine) — or further outward, from the tenth costal cartilage — passing from the lower border of the right costal arch as far down as necessary.

Oblique subcostal incision: — gives better approach to the subhepatic space — and especially to the right end of the liver. It may be extended upward or downward obliquely, parallel with the costal arch. It will cross the external oblique and transversalis at a right angle, and about coincide with the fibers of the internal oblique. It affords a somewhat better chance to preserve some of the abdominal nerves, which is especially desirable.

Anterior vertical incision: — gives best access to gall-bladder and ducts — together with a very good exposure of the liver. A vertical incision over some part of the right rectus, preferably, with retractions, — or in the right linea semilunaris — or more externally, from the tenth costal cartilage — can be increased directly downward to give room. Its lower end may also be extended transversely, or obliquely, toward the median line or toward the back — giving an angular flap. A continuation of the original incision gives a very extensive approach to the abdominal cavity — and even the pelvis. The simple vertical incision will cross the external and internal oblique muscles obliquely, and the transversalis at a right angle — and will cross the abdominal nerves at a right angle. See Operations for the Exposure of the Liver, in General, p. 441.

In operating to expose the liver it will often be found, when the liver is reached, that its serous surface is adherent to the parietal peritoneum — and, therefore, that its substance can be entered without involving the general peritoneal cavity.

As adjuncts to the satisfactory exposure of these sites the following maneuvers are helpful: — (*a*) the reversed Trendelenburg position — (*b*) firm upward traction upon the liver and right costal arch — (*c*) passage of the left index through the foramen of Winslow and the left thumb over the lesser omentum, thus embracing that structure between the digits.

When the round ligament is encountered descending to the umbilicus and is severed, it should be sutured at the end of the operation.

Standing, the lower border of the liver is about 1.2 to 2.3 cm. ($\frac{1}{4}$–$\frac{1}{2}$ inch) below the costal cartilages; — reclining, the lower border recedes until about 2.5 cm. (1 inch) above the lower costal cartilages. This change in position, and change during respiration, must, therefore, be allowed for in suturing the liver to the parietes.

Anteriorly, the gastrodiaphragmatic sinus (between the lower edge of the pleura and the diaphragm) makes it possible to reach and pierce the diaphragm more easily and without involving the pleura, in operating intrathoracically, – therefore the subpleural operation is more generally done anteriorly or anterolaterally. This sinus is absent posteriorly, and an incision here would pass through the pleura (if that structure were not raised from the course of incision by blunt separation) – hence the posterior operation is generally transpleural.

In the transpleural operation, where the two layers of pleuræ cannot be sutured *in situ* – the parietal pleura is incised – its edges are grasped with forceps, or traction sutures (to keep them from receding out of the way) – then the visceral peritoneum is incised – and the edges of the parietal and visceral peritoneum are whipped together by an overhand stitch.

The liver is a very vascular organ, and, in addition, a very friable organ – two circumstances which make both for very free bleeding of cut or wounded surfaces, and often for very great difficulty in controlling the bleeding.

The chief conditions which call for hemorrhage control are – the repair of wounds of the liver; incisions into the substance of the organ, in the course of operations; and, especially, in the partial excision of the liver in the removal of tumors.

The technical procedures adopted for the control of bleeding, by the simpler methods of suturing, will be described under the Treatment of Wounds of the Liver, p. 454, – and the more complex methods of suture control and suture coaptation of wound surfaces, as well as other methods of hemorrhage control, will be given under Partial Excision of the Liver for Tumors, p. 475.

EXPLORATORY PUNCTURE OF THE LIVER

Description.—Resorted to for withdrawal of fluid for diagnostic purposes – generally pus or hydatid. An operation involving some danger. The site of puncture is generally determined by physical signs – and the puncture is made by the safest and most direct route into the supposed lesion.

Preparation.—Site asepticized.

Position.—Such as to best expose the region.

Landmarks.—Anatomic outline of liver; physical signs.

Operation.—The exploration is usually made with the needle of an exploratory syringe. The depth of puncture is to be guarded by the right index on the barrel of the needle – and to be largely determined in advance by the estimated thickness of the abdominal or thoracic wall and intervening liver substance at the site to be punctured. If no physical sign guiding to the seat of exploration exist, puncture may be made in several sites: – (1) Laterally, in the ninth, tenth, or eleventh intercostal space, in the midaxillary line – the most general position – and the tenth space being the one most frequently used; – (2) Anteriorly, in the subcostal angle, over the known region of the liver (on anatomic grounds) – in the space bounded, above, by the costal arches, and, below, by a line from the right ninth costal cartilage to the left eighth costal cartilage. In abnormal cases the liver may, of course, be looked for considerably lower than usual; – (3) Posteriorly, in the tenth intercostal space on the right. The liver is in relation, posteriorly, with the tenth and eleventh ribs – and the pleura comes down to the twelfth, or lower – hence the pleura would be pierced if not displaced; – (4) Transthoracic – preferably subpleural – rarely transpleural. See subpleural and transpleural operations, pp. 450 and 454; (5) Below the free border of the ribs – where the liver dulness extends below; – (6) At any point from which liver substance can be reached with minimum risk and danger – the guides being anatomic and physical. Upon the withdrawal of the needle the puncture wound is generally sealed with sterile gauze and collodion _ or is followed by incision and evacuation of the fluid.

Comment.—Wounding of the lung should be avoided _ and also piercing of the pleura or diaphragm, unless unavoidable. The diaphragm would be penetrated by any puncture above the lower border of the ribs or costal arch. The pleura would be penetrated by any puncture above the eighth right rib in the nipple line _ the ninth right rib in the midaxillary line _ (the tenth left rib in the same line) _ and the twelfth right rib in the posterior scapular line. The lung would be penetrated by any puncture above the sixth costosternal articulation in front _ the sixth right rib in the nipple line _ the eighth right rib at the midaxillary line _ and the right twelfth rib in the scapular line.

The chief danger in exploratory puncture is that pus, if encountered, is apt to be diffused among neighboring structures, both from the needle wound in the liver and by the needle point in the act of withdrawal. For this reason, while it is a more formal procedure, some Surgeons prefer only to use the needle, if at all, after the exposure of the surface of the liver by operation through the overlying abdominal or thoracic wall. In this connection see Operation for Hepatic Abscess by Trocar and Cannula, p. 464.

Under no circumstances should exploratory puncture be performed unless all be in readiness for immediate operation if pus be found.

OPERATIONS FOR THE EXPOSURE OF THE LIVER, IN GENERAL

Owing to the very large size of the liver _ the many aspects upon which it abuts _ and its approachability through transperitoneal, transpleural, and subpleural routes, as well as through routes which involve neither pleura nor peritoneum, an unusually large number of technical procedures have been worked out for exposing the various parts of the organ.

It will, therefore, be seen that the method of approach will be determined by the nature of the pathologic condition for which its location is adopted, and the special technical procedure to be accomplished. The methods of exposing these various sites most generally employed will be here given _ without reference to the individual object to be accomplished through the exposure.

The routes through which the gall-bladder tract is best exposed will be separately considered, in Chapter LXX. Through some of these the adjacent parts of the liver may be also reached.

It is especially desirable that the method of approach should furnish such exposure of the particular site to be operated upon as to make possible free manipulation.

EXPOSURE OF THE ANTERIOR ASPECT OF THE LIVER AND OF THE GALL-BLADDER

BY ANTERIOR OBLIQUE INCISION PARALLEL WITH THE COSTAL ARCH

Description.—The liver is exposed along the right costal arch by an incision which parallels that arch and is placed 1.3 to 2 cm. ($\frac{1}{2}$–$\frac{3}{4}$ inch) below it. Resorted to where the more central portion of the anterior aspect of the liver and gall-bladder region is to be exposed. This approach, however, does not spare muscles or nerves.

Preparation _ Position.—As for abdominal section, but with support under the costal arch.

Landmarks.—Right costal arch.

Incision.—Parallel with and from 1.3 to 2 cm. ($\frac{1}{2}$–$\frac{3}{4}$ inch) below the right costal arch _ beginning near the right linea semilunaris (which runs downward from the ninth rib to the spine of the pubis) — and extends as far downward and outward, below the costal arch, as considered necessary.

Operation.—Incise skin — fascia — external oblique (transversely) — and internal oblique (in cleavage line). The superior epigastric artery may be cut at the inner end of the incision, if the inner end reaches the outer border of the rectal sheath — if so, it is ligated. The abdominal nerves lie between the internal oblique and transversalis, crossing the line of incision, and an attempt should be made to draw them aside if encountered. The transversalis muscle is then divided obliquely to its fibers. In long incisions much division of muscles and nerves must occur. In short incisions much displacement in intramuscular cleavage lines and saving of nerves may be accomplished. Divide the transversalis fascia, subperitoneal areolar tissue, and peritoneum in the original line — and retract the wound well.

Adhesions are looked for as soon as the abdomen is opened. If encountered, intervening between a site of pus to be evacuated and the abdominal wall, they are carefully preserved — that they may serve as a protection to the general peritoneal cavity in opening these collections of fluid. If the object be the exposure of the liver on other grounds, the adhesions are separated by blunt dissection or are divided between ligatures.

If the operation be for the liberation of pus, the details of procedure are as described under Hepatotomy, p. 458.

Having accomplished the object of the operation the abdomen is closed in the usual manner.

Comments.—Kocher, in employing the oblique subcostal incision, begins at the tip of the ensiform cartilage, and passes two fingerbreadths below and, at first, parallel with the costal margin — after which the incision passes downward to the muscular fibers of the obliquus externus, which are limitedly incised. This incision severs the rectus obliquely, throughout its entire width — but the nerves which supply it, passing obliquely downward and inward upon the transversalis, are carefully drawn aside. The branches of the internal mammary which are cut in the muscle are tied.

As far as it is possible to do so, all incisions of muscles should be made parallel with the course of the nerves supplying the abdominal wall — with subsequent retraction in such manner as to spare the nerves.

When nerves are divided, they should be carefully sutured at the end of the operation.

The margins of divided muscles, whether the division be transverse, oblique, or in the course of their fibers, should be sutured with catgut in the final closure.

If greater exposure of the left lobe of the liver be required than is secured by the incision as above described, its left end may be extended further toward the left, and the inner aspect of the left rectus muscle limitedly cut, without entirely dividing it.

EXPOSURE OF THE ANTERIOR ASPECT OF THE LIVER AND OF THE GALL-BLADDER BY VERTICAL INCISION, JUST TO THE RIGHT OF THE MEDIAN LINE, WITH RIGHT ANGULAR OR HOOKED EXTENSION

PERTHES' TECHNIC

Description.—Next to the exposure of the liver by the oblique incision parallel with the right costal arch, this probably furnishes the best form of combined exposure of the liver and gall-bladder tract. This technic makes special provision for the preservation of the nerve-supply to the abdominal muscles, by retraction of the transversely divided rectus muscle and exposure of the nerves, — and against hernia, by the placing of the cutaneous, muscular, and peritoneal incisions all in totally different positions and directions.

The technic is pictured under the gall-bladder operations.

Preparation — Position.—As for median abdominal section.

Landmarks.—Ensiform cartilage; linea alba; outline of right rectus muscle; right costal arch.

Incision.—Beginning just under the xiphoid cartilage, and slightly to its right, the incision passes vertically downward, at a distance of about 2 cm. (¾ inch) to the right of the median line — as far as a point to the same distance to the right of the umbilicus. Here the incision takes a turn to the right, and passes outward and somewhat upward toward the costal border.

Operation.—The skin and fascia are divided throughout the entire angular incision — but the anterior layer of the rectal sheath is incised only in the vertical portion of the cut. Through the vertical incision the inner border of the rectus is defined and mobilized by blunt dissection. Provision is now made, in advance, for repairing the transversely divided rectus. An index-finger is inserted between the rectus and the posterior layer of the rectal sheath — and passed transversely outward, under the site along which the muscle is to be transversely divided. Guided by the finger thus introduced, two tiers of interrupted chromic catgut sutures are placed and tied — the tiers being about 1.2 cm. (½ inch) apart — and each tier consisting of three or four sutures (Fig. 3668). These sutures anchor the rectus to the anterior rectal sheath — and prevent the extreme retraction of the cut ends of the rectus when the division is made.

The deep transverse portion of the incision is now carried through the anterior layer of the rectal sheath and the entire rectus muscle — the transverse incision passing midway between the two tiers of sutures. An angular flap will be thus formed — consisting of skin, fascia, anterior layer of the rectal sheath, and the rectus muscle — and this is displaced upward and outward over the costal border. In the act of accomplishing this displacement the intercostal nerves supplying the abdominal wall, which enter the deep and outer aspect of the rectus muscle, will be put upon the stretch and brought into view — and very carefully guarded. These are to be carefully preserved from harm — or, from the nature of the subsequent incision, need they be cut. This is accomplished by dividing the posterior layer of the rectal sheath and the peritoneum in the oblique manner shown in the illustration last mentioned — the incision passing to the inner aspect of the nerves, and parallel with the costal arch, from the lowermost to the uppermost limits of the wound.

If still additional room be necessary, the horizontal part of the incision is carried outward still further — separating the fibers of the external and internal oblique and the transversalis in their cleavage line.

In closing the abdomen — upon completing the object of the operation — the transversely divided rectus is reunited by chromic catgut sutures, which pass through anterior and posterior layers of the rectal sheath, and rectus — and, at the same time, pass above the upper and below the lower tier of sutures passed prior to dividing the muscle, so that they will be less apt to tear out. The union will be closer, if the cut margins are first united by finer catgut. Mattress-sutures may be preferable to ordinary sutures for the suturing which includes the two tiers of interrupted sutures. The posterior rectal sheath is closed by continuous chromic catgut in the line of its oblique division — and the anterior sheath, similarly, in the line of its vertical division.

Comments.—It will be seen that the nerves to the abdominal muscles are not cut — that no two of the three incisions are opposite each other, so that the likelihood of subsequent hernia is minimized _ and that the line of approach is very direct.

The liver may also be exposed by a straight median or right paramedian incision.

In any of the methods of approach in which the round ligament is accessible, reasonable traction upon this ligament may be employed for bringing the liver lower and more prominently into the field.

TRANSPERITONEAL EXPOSURE OF THE DOME AND ANTERIOR ASPECT OF THE RIGHT LOBE OF THE LIVER

BY CHONDROPLASTIC OR COSTOCHONDROPLASTIC FLAP

Owing to the protected subchondral, subcostal, and subdiaphragmatic position of the upper aspect of the right lobe of the liver, its satisfactory exposure requires either the excision or temporary resection of the overlying cartilages and ribs. When this is done, and the liver depressed, access to its upper surface is secured. Where pus drainage is necessary and the cut chondro-osseous tissue is apt to become infected, excision of the necessary parts of cartilages and ribs is often performed _ but where these conditions are not apt to be encountered the temporary turning back of a composite chondro-osseous flap is more desirable.

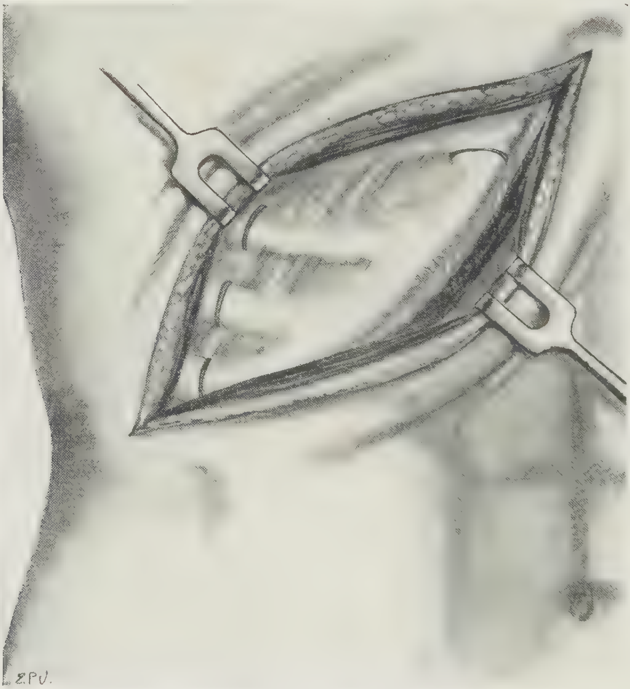


Fig. 3632.—Transperitoneal Exposure of the Dome and Anterior Aspect of the Right Lobe of the Liver _ By Chondro-osteoplastic Flap _ I; _ The soft parts have been retracted from the chondral margin _ the seventh cartilage divided at the sternum _ and the ninth, eighth, and seventh costal cartilages divided just in front of their corresponding ribs.

The limit of the pleura reaches, in the sternal line, down to the upper border of the seventh costal cartilage, _ in the parasternal line, to the middle of the seventh costal cartilage, _ in the mammary line, to the under border of the seventh costal cartilage, _ in the axillary line, to the ninth rib, _ behind, near the spine, to the twelfth rib.

One, therefore, can, without danger of wounding the pleura, cut through the costal cartilages of the eighth and ninth ribs, from the border of the sternum to the mammary line _ while opposite the seventh costal cartilage it is necessary to guard the pleura lying behind it.

A slightly curved incision is made from the xiphoid cartilage to the anterior end of the bony portion of the tenth rib, passing parallel with the chondral arch, and about 1.2 to 2 cm. ($\frac{1}{2}$–$\frac{3}{4}$ inch) below it. Between the rectus and external oblique muscles, on the outer aspect, and the internal oblique and transversalis, on the inner aspect, the lower border of the costal arch is exposed, and can be easily freed. The insertion of the seventh costal cartilage is divided at the sternum _ and similarly, the ninth, eighth, and seventh costal cartilages are divided just distal to bony ends of their corresponding ribs (Fig. 3632) _ or, if necessary, the ribs themselves may be divided still further posteriorly. Care is especially exercised to avoid wounding the pleura behind the seventh cartilage. The portion of the chest wall thus mobilized is then displaced outward and upward, by means of a broad pronged retractor.

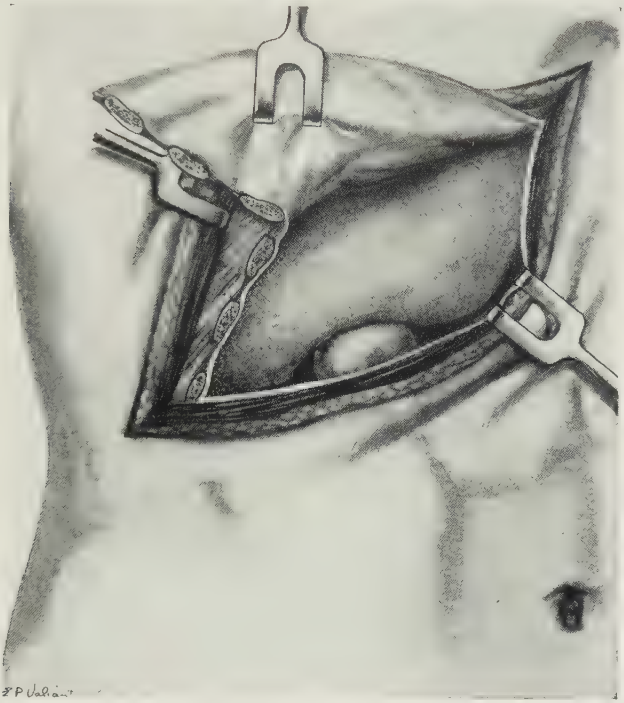


Fig. 3633.—The Same _ II; _ The chondroplastic flap has been retracted outward and upward _ thereby exposing an increased area of the dome of the liver _ and the fundus of the gall-bladder.

A large part of the upper surface of the liver and the right hypochondrium are thus exposed (Fig. 3633) _ and the extent of this exposure may be further increased by traction upon the round ligament _ and even still further by partly dividing the suspensory ligament, and depressing the liver with broad retractors.

After having accomplished the object of the operation, the displaced chondroplastic flap is turned back into place — the divided cartilages sutured with chromic catgut, or kangaroo-tendon — and the wound of the soft parts closed as usual, with or without drainage, as indicated by the special case.

Comments.—When it is necessary to include part of the bony ribs in the flap, as well as the cartilages, the original incision is carried further backward below the costal arch. The temporary division of the suspensory ligament may be resorted to — and even the simultaneous temporary turning back of a left costochondral flap, if it be necessary — for the freest exposure of the liver, gall-bladder, gall-ducts, and stomach. The chief danger is the possibility of opening the pleural cavity — to avoid which one should not carry the division of the ribs too high — not, with impunity, higher than the seventh interspace (between the seventh and eighth ribs).

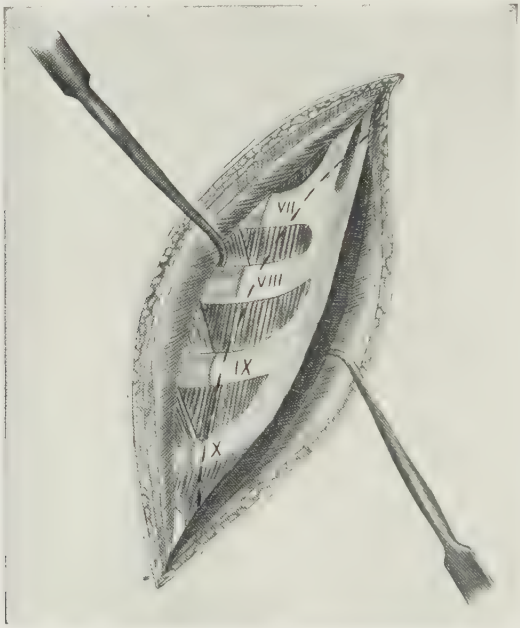


Fig. 3634.—Chondroplastic Resection of the Chest Wall with Inward Displacement of the Flap — I; — The soft parts overlying the costal arch have been incised and retracted — exposing the cartilages of the seventh, eighth, ninth, and tenth ribs. (Redrawn from Guibe.)

Instead of hinging the costochondral flap upward and outward, as just described, the composite flap may be hinged downward and inward — in the following manner: — the skin, fascia, and overlying muscle-fibers are divided below and parallel with the costal arch — until the plane of the costal cartilages is reached. The cartilaginous portion of the ribs is divided with a bistoury, carefully guarding the underlying soft parts. The tenth and ninth cartilages are divided just to the inner side of the chondrocostal articulations. The eighth cartilage is generally divided in three places — externally, just within the chondrocostal articulation — internally, just without the chondrosternal articulation — and in the middle, through the band of union of the eighth to the seventh cartilage (when this exists). Between the cartilages the intercostal muscles and membranes are incised (Fig. 3634). The incised cartilaginous margin is then seized and turned downward and inward _ separating with a bistoury the muscular attachments of the diaphragm and transversalis, closely hugging the cartilages in the act (Fig. 3635). As soon as the chondroplastic flap has been sufficiently displaced the muscular fibers of the diaphragm or transversalis, which form the floor of the wound, are incised _ thus opening the peritoneal cavity. The chondroplastic flap is then well depressed and the outer lip of the wound well elevated _ when the superior surface of the liver is exposed by retracting the liver downward and, if necessary, by temporarily dividing the suspensory ligament _ and the inferior aspect and gall-bladder region by retracting the liver upward. As the end of the operation, in closing the wound, the deeper portion is sutured by carrying the suture through the intercostal spaces and the diaphragm, on the outer side, and through the transversalis and internal oblique, on the inner side _ thus bringing together the soft parts of the thorax, and, with them, the incised cartilages. The overlying superficial muscles are then sutured _ and the skin closed as usual. If considered necessary, the surfaces of the severed cartilages may be sutured through previously pierced holes. Indeed, the temporarily displaced costal arch may be completely severed from its soft attachments and discarded _ though its retention is preferable. If necessary, a drain may be carried beneath the replaced costal arch.

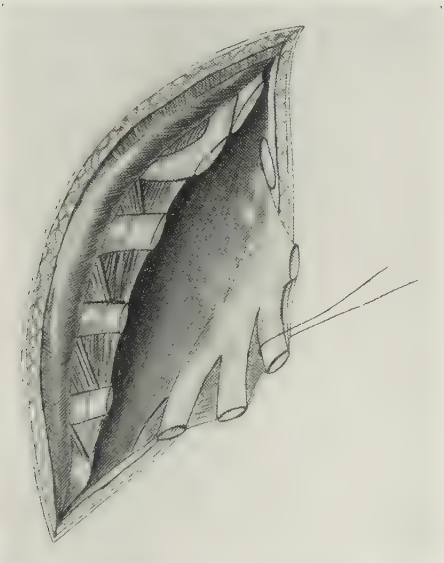


Fig. 3635.—The Same _ II; _ The costal margin incised and turned forward. (Redrawn from Guibe.)

TRANSPERITONEAL EXPOSURE OF THE LEFT LOBE OF THE LIVER

BY MEDIAN ABDOMINAL SECTION

The left lobe of the liver is well exposed by means of an incision made in the linea alba, extending from the ensiform cartilage as far toward the umbilicus as necessary. If still greater exposure of the left lobe is required than this affords, a transverse incision through a part of or all the left rectus muscle may be made from the lower end of the vertical incision.

The convexity of the left lobe of the liver is particularly well exposed by this incision _ and even additional access may be had to its dome by downward traction of the round ligament.

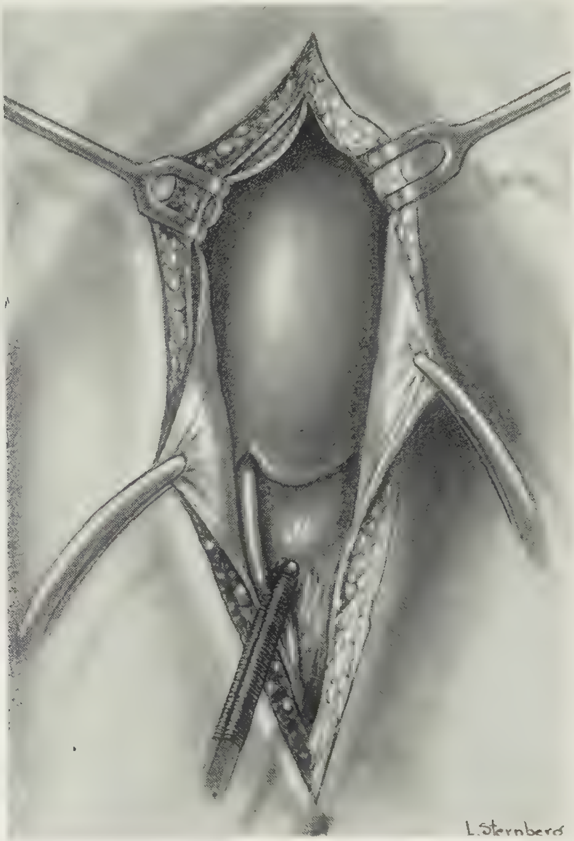


Fig. 3636.—Exposure of the Liver by Median Incision; _ An additional area of the dome of the organ may be brought into the field by downward traction upon the round ligament. The anterior margin of the liver is here shown drawn well over the surface of the stomach _ from the lower border of which latter organ the gastrocolic omentum is seen extending downward.

The features of the exposure are shown in Fig. 3636.

SUBCOSTAL EXPOSURE OF THE ANTERIOR ASPECT OF THE LIVER

BY VERTICAL INCISION THROUGH THE OUTER PART OF THE RIGHT RECTUS MUSCLE

Description.—A free exposure is thus given _ which may be lengthened so as to give access to both peritoneal and pelvic cavities. The incision may also be placed to the outer side of the right semilunar line _ or in the semilunar line.

Preparation _ Position.—As for abdominal section.

Landmarks.—Right Linea Semilunaris (which extends from the ninth right costal cartilage to the pubic spine, passing within 7.5 cm. [3 inches] of the umbilicus); right costal arch.

Incision.—Vertically downward to the inner side of the right semilunar line, beginning at the right ninth costal cartilage and extending as far as necessary.

Operation.—Having incised the skin and fascia, and split the outer sheath of the rectus vertically, the rectus is either divided in its cleavage line and retracted _ or its outer border is exposed by blunt dissection and the entire muscle displaced to the inner side. In either event, especially in long incisions, considerable damage is done to the nerve-supply. The posterior layer of the rectal sheath is incised in a line corresponding with the division of the anterior layer of the sheath _ the peritoneum opened _ and the liver exposed.

If, instead of incising vertically through the outer part of the rectus muscle, the vertical incision is made just to the outer side of the right semilunar line, different tissues are cut. In the latter instance incise skin _ fascia _ external oblique (obliquely) _ internal oblique (obliquely) _ abdominal nerves between internal oblique and transversalis are almost necessarily divided (except in very short incisions they may sometimes be displaced) _ transversalis muscles (transversely) _ transversalis fascia, subserous areolar tissue, and peritoneum _ entering the abdomen in the original line. All hemorrhage is controlled _ the lips of the wound retracted _ and the liver exposed.

TRANSPERITONEAL EXPOSURE OF THE LOWER LATERAL BORDER OF THE LIVER

BY AN INCISION PARALLEL WITH AND JUST BELOW THE RIGHT TWELFTH RIB

Description.—The general features of the operation are the same as by the anterior oblique subcostal incision _ the steps of the operation differing only in so far as determined by anatomic circumstances. Chiefly applicable where the lower lateral aspect of the liver is to be exposed.

Preparation.—As for abdominal section.

Position.—Patient rests upon opposite side, with cushion under the sound side to round out the involved side; Surgeon may stand behind or in front of patient; Assistant opposite.

Landmarks.—Right twelfth rib, in the midaxillary region.

Incision.—Parallel with and about 1.3 to 2 cm. ($\frac{1}{2}$–$\frac{3}{4}$ inch) below the right twelfth rib, with its center about opposite the midaxillary line.

Operation.—Incise skin _ fascia _ external oblique (obliquely) _ latissimus dorsi (transversely, if the incision extend that far backward) _ serratus magnus (in its cleavage) _ internal oblique (obliquely) _ the nerves between the internal oblique and transversalis being guarded as well as possible _ transversalis muscle (in cleavage line) _ transversalis fascia, subserous areolar tissue, and peritoneum in the original line. All hemorrhage is controlled _ the wound retracted _ and the liver brought into the field.

Comment.—Unless the liver be enlarged, but small part of its lower border is accessible through this incision _ except by the strong upward retraction of the twelfth rib, and the downward retraction of the lower lip of the wound.

EXTRAPERITONEAL EXPOSURE OF THE POSTERIOR BORDER OF THE RIGHT LOBE OF THE LIVER

BENEATH THE TWELFTH RIB

A band of the posterior surface of the right lobe of the liver is uncovered by peritoneum. The width of this non-peritoneal band, upon the right lobe, is estimated, by Koerte, to be from 3 to 4 cm. ($1\frac{3}{16}$–$1\frac{9}{16}$ inches), and about 7.5 cm. (3 inches), as given in Gray's Anatomy _ and is much narrower upon the left lobe. The non-peritoneal surface represents the area upon the posterior aspect of the liver which lies between the line of reflection of the upper, or anterior layer of the coronary ligament (above which is the upper surface of the liver), and the line of reflection of the lower layer of the coronary ligament (be lowwhich is the under surface of the liver). This non-peritoneal aspect of the liver is in direct contact with the diaphragm, to which it is connected by areolar tissue, in which are numerous veins connecting the portal and systemic systems.

Through the above-designated non-peritoneal aspect of the liver the organ can be entered without transgressing the free peritoneal cavity. This is accomplished by a right-sided transverse lumbar incision, running parallel with the twelfth rib. After cutting through the abdominal muscles, and limitedly incising the quadratus lumborum and long muscles of the back, the lower border of the twelfth rib is exposed. The twelfth rib is then either forcibly retracted upward _ or, if necessary, is subperitosteally excised _ being careful to avoid the pleura. The Surgeon then forces his way forward, toward the posterior border of the liver, by blunt dissection, either to one side of the kidney or after slightly displacing it.

This route of approach is sometimes employed in opening abscesses or in operating upon echinococcus cysts.

EXPOSURE OF THE LIVER BY THE INTERCOSTAL SUBPLEURAL ROUTE

BY INTERCOSTAL INCISION BELOW THE LEVEL OF THE PLEURA

Description.—This incision, which is made in an intercostal space below the level of the pleura, rarely gives sufficient room _ and is indicated only in cases where abscesses or fluid point here and adhesions have, in all probability, protected surrounding regions. In the following description the operation site will be supposed to be in the right tenth interspace in the midaxillary line.

Preparation _ Position.—As for intercostal thoracotomy (q. v.).

Landmarks.—Right tenth and eleventh ribs in the midaxillary line.

Incision.—Midway between lower border of the right tenth and the upper border of the right eleventh rib _ in the midaxillary region.

Operation.—The steps of the operation are the same, practically, as those for Intercostal Thoracotomy (q. v.) _ with the exception that in the present instance the incision is made below the level of the pleura. As an operation, owing to the small amount of room which it affords, it is indicated only in those cases in which the liver is supposed to be adherent to the diaphragm opposite the site of incision (either naturally or by pathologic process). If during operation it be found that the liver be not adherent to the diaphragm, parts of one or two ribs should be excised _ and the operation be completed as given in the subpleural operation to be next described.

EXPOSURE OF THE LIVER BY THE SUBPLEURAL ROUTE

BY PARTIAL EXCISION OF ONE OR MORE RIBS BELOW THE LEVEL OF THE PLEURA

Description.—The liver is here approached transthoracically, but the incision being placed below the normal level of the pleura, the pleura is not, ordinarily, brought into the field of operation. In the following account part of the right eleventh rib in the midaxillary line will be removed.

Preparation _ Position.—As for Thoracotomy by the partial excision of a rib.

Landmarks.—The special rib nearest the site to be exposed.

Incision _ Operation.—As for the Partial Subperiosteal Excision of a Rib (q. v.) _ up to the point of the removal of the rib. The posterior layer of periosteum, forming the bed in which the rib has lain, is then incised in its center in its long axis. If more room be required than furnished by the partial excision of one rib, two or more ribs are excised in part. Having passed through the thoracic wall, the diaphragm is exposed and incised _ in a line corresponding with the direction of its muscle-fibers at the site incised. The edges of the diaphragmatic wound are sutured to the convex surface of the liver, if not already adherent. If adhesions be present, or if haste be necessary, the liver is incised at once. If haste be unnecessary, and no adhesions be present, the wound, after the above suturing, is packed with gauze for two or three days, until adhesions form _ and the organ then incised.

EXPOSURE OF THE LIVER BY THE SUBPLEURAL ROUTE

BY PARTIAL EXCISION OF ONE OR MORE RIBS OPPOSITE THE PLEURA

Description.—Parts of one or more ribs are excised subperiosteally above the level of the pleura _ the pleura is exposed but not opened _ and is carefully separated from the thoracic wall and diaphragm and displaced upward _ the diaphragm being thus exposed, and the liver entered through its substance. In the following account, parts of the seventh and eighth right ribs in the antero-lateral aspect of the chest will be removed.

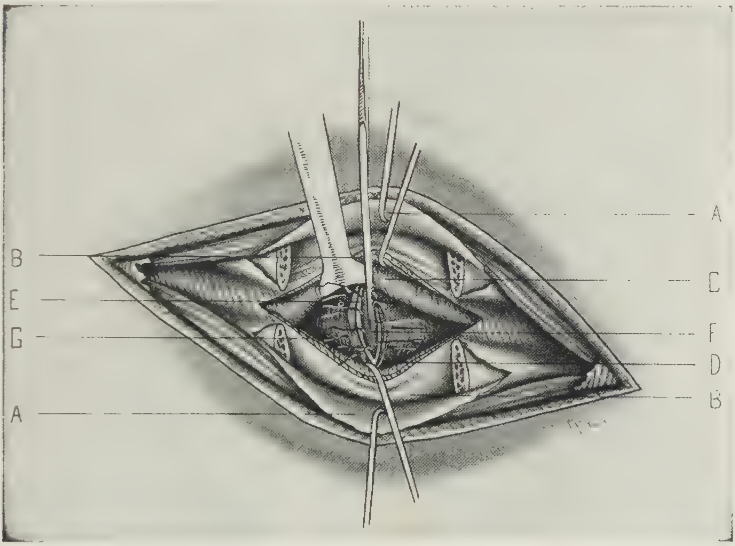


Fig. 3637.—Exposure of Liver by Subpleural Route by Excision of Parts of Two Ribs Opposite the Pleura: _ A, A, Upper layer of periosteum and thoracic muscles retracted; B, B, lower layer of periosteum and intercostal muscles retracted; C, pleura detached and retracted upward; D, diaphragm incised; E, incised margin of parietal pleura; F, convex surface of liver; G, sutures uniting edges of diaphragm and parietal peritoneum to surface of liver.

Preparation _ Position.—As for Thoracotomy.

Landmarks.—The rib or ribs overlying the involved site.

Incision _ Operation.—The operation is conducted as a Partial Subperiosteal Excision of one or more Ribs _ up to the removal of the rib. The subperiosteal bed of the rib is very carefully incised in the center of its long axis _ cautiously recognizing but not incising the costal pleura _ which is to be preserved with the greatest care from the smallest cut or tear (on account of the respiratory complications often arising from the entrance of air into the pleura, with the possible collapse of the lung, and the possible infection of the pleura). The costal pleura is carefully detached by blunt dissection, largely aided by the back of the Surgeon's fingers – first detaching it from the ribs, until its lowest thin edge is reached – then from the upper surface of the diaphragm – and finally displacing it upward and retaining it there by blunt, rounded retractor, or gauze packing. Thus the upper surface of the diaphragm, as far inward as necessary, is freely exposed – with the upper convex surface of the liver immediately below it (Fig. 3637).

The operation is now completed in one or in two stages: – (*a*) In One Stage: – The diaphragm is incised over the site of fluid, if present – the edges of the diaphragmatic wound are slightly separated – and these edges are sutured with chromic gut (by means of a curved needle in a holder) to the upper surface of the liver, in the form of an ellipse. If adhesions be present between liver and diaphragm, this suturing is unnecessary. In addition (to either suturing or adhesions), gauze is packed around the region, further guarding against infection. To relieve the tension part of the contents of the cavity is first aspirated. The liver is then incised and drained. The wound is closed up to the site of drainage – so suturing the parts that the thoracic cavity is shut off and the pleura prevented from coming into the region of the wound. (*b*) In Two Stages: – The diaphragm is sutured as above to the liver and the wound packed – and, after two or three days, when adhesions have occurred, the liver is incised and drained – and the wound treated with the same precautions as just given.

Comments.—Parts of at least two ribs should generally be excised – to give the necessary room to meet the difficulties which are apt to arise in the progress of the operation.

Where, from the position of the opening it is possible to do so, it is well to unite the edges of the diaphragm to the lowermost edges of the thoracic wound – thus giving freer drainage and better protection of the neighboring parts from infection.

EXPOSURE OF THE CONVEXITY OF THE LIVER BY THE TRANSPLEURAL ROUTE

THROUGH THE PARTIAL EXCISION OF ONE OR MORE RIBS, OPPOSITE THE PLEURA

Description.—Following the subperiosteal excision of parts of one or more ribs, no attempt is made to avoid the pleura, but care is taken not to open it prematurely. After entering the thoracic cavity, the costal and diaphragmatic pleuræ are recognized – their surfaces are then sutured together in the form of a circle or an ellipse – and an opening is made through their united surfaces – at once if necessary, – or after two or three days, if haste be unnecessary. Thus an attempt is made to prevent the invasion and infection of the pleural cavity. The operation is generally inferior to the subpleural method, which should always be practised if possible – reserving the method just described for those cases in which the pleura cannot be thus separated and pushed above the seat of operation. In the following account part of the seventh right rib will be excised in the midlateral aspect of the chest. Usually an extent of from 6 to 8 cm. ($2\frac{6}{16}$–$3\frac{2}{16}$ inches) is excised subperiosteally from the seventh, eighth, or ninth ribs.

Operation.—In the following procedure part of the right eighth rib will be excised subperiosteally in the midlateral region. The incision of approach, at this site, usually involves the anterior portion of the latissimus dorsi and the serratus magnus – and an effort is made to carry the cut, while passing over the rib to be excised, in such a way as to enable the fibers of these muscles to be separated rather than cut, or at least obliquely cut. A portion of the elected rib, at the selected site, is subperiosteally excised. The under layer of periosteum, forming the bed of the rib, is then either split down its center or entirely excised _ avoiding the wounding of the pleura. If parts of two adjacent ribs are excised, the incision into the thoracic cavity may be made between them, or the soft tissues intervening between the cut ends of the ribs may be excised. The intercostal vessels are generally ligated at both ends of the rib section _ while the intercostal nerve should be drawn out of the way.

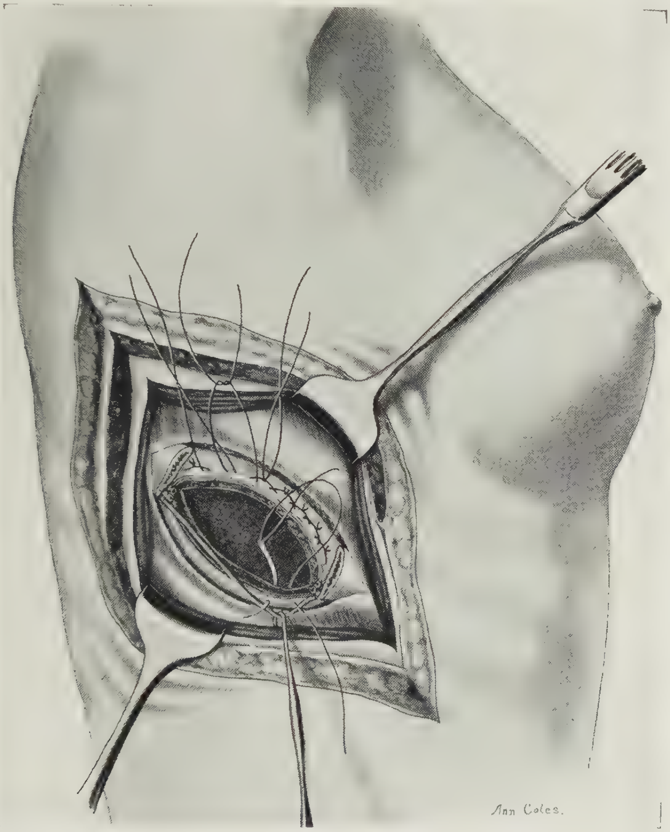


Fig. 3638.—Exposure of the Convexity of the Liver by the Transpleural Route _ Through the partial excision of the eighth rib, opposite the pleura, in the midlateral region; _ the skin, latissimus dorsi, and serratus magnus have been incised, and their margins retracted. Part of the eighth rib has been excised _ the intercostal vessels doubly ligated _ and the intercostal nerve retracted. The periosteal bed has been incised _ and the parietal pleura, diaphragmatic pleura, and diaphragm sutured together over an elliptic area, after which an incision has been made through these structures exposing the surface of the liver.

The periosteal bed of the rib is now incised (or excised) _ together with the parietal fascia _ after which one comes down upon the parietal pleura. This is carefully preserved. One may come into contact with the lower border of the lung. If this be encountered, it is pushed upward by manipulating through the unopened parietal pleura. The diaphragmatic pleura and diaphragm are brought into the wound and drawn forward _ so that they can be sutured together by an interlocking stitch, upon a curved needle, in a holder, which passes through the parietal pleura (unless this has been excised), diaphragmatic pleura and, if possible, the upper layer of the diaphragm, thus shutting off the pleural cavity. At this stage it becomes necessary to decide as to whether the operation is to be completed as a single step procedure (without awaiting adhesions), or in two stages (after the pleural cavity is shut off by pleural adhesions.

(*a*) In One Stage: _ Through the center of the area thus sutured the two pleuræ are incised _ through this incision the diaphragm is exposed _ the margins of the pleuræ are now sutured as one layer to the diaphragm, over an elliptic area, with continuous suture of silk or fine chromic gut, carried upon a fully curved needle in a holder unless found held by the original suturing. The surrounding area is packed off with gauze, in addition _ the diaphragm is incised _ and the edges of the diaphragm stitched, in turn, to the liver with chromic gut _ after which the liver is incised. The technic is shown in Fig. 3638.

(*b*) In Two Stages: _ Same as in the single stage method _ except that after suturing the double layer of pleura together, and, at the same time, to the diaphragm, in the form of a circle or ellipse _ the area is packed with gauze for two or three days _ after which the operation is completed as above. In such cases the diaphragm will usually be found adherent to the liver (when the operation falls over the peritoneal aspect of the liver). If, however, upon exposing the liver through the diaphragm, no adhesions are found, the margins of the diaphragmatic wound can be stitched to the liver surface _ the wound packed, and a delay of two or three days awaited, if haste be unnecessary.

Comment.—If the two pleuræ cannot be sutured, and time be available, incise the parietal pleura _ pack the wound for a few days, until the two pleuræ have united around the margins _ then incise the visceral pleura and diaphragm _ similarly stitching the diaphragm to the liver for a day or two, if desired.

If the situation of the wound make it possible, it is well to suture the edges of the diaphragmatic and thoracic wounds together.

In completing the operation in a single stage, the two layers of the pleura may be found adherent _ or the diaphragm may be found adherent to the liver _ or all of these structures may be united, so that both pleural and peritoneal cavities are shut off.

The method of dealing with the parts, where portions of two ribs are ex cised, has been covered in the chapter upon the Thoracic Wall.

The convex surface of the liver may also be exposed by thoracoplastic flap methods, as previously described.

OPERATIVE TREATMENT OF WOUNDS OF THE LIVER

Classification of Liver Wounds.—Wounds of the liver fall under the following categories:

(*A*) **Open Wounds of the Liver**; _ with communication between skin and liver: _

Punctured (stab), _ Incised, _ Lacerated (rupture), _ Gunshot. Any of these may involve part of the thickness of the liver _ or entirely penetrate it.

(*B*) **Subcutaneous Wounds of the Liver**; _ in which no communicating skin wound is present. They usually result from contusions and crushes. Kehr divides these as follows: _

(*a*) Separation of Glisson's capsule, with subcapsular hematoma.

(*b*) Rupture of the hepatic substance, together with laceration of the capsule.

(*c*) Central laceration of liver substance; sometimes resulting in hematomata, which may eventuate in cysts or in abscesses.

And (*d*) to these must be added (unless included in *B*, above) such subcutaneous injuries, sometimes extensive, which may result from the wounding of the liver by a broken rib, in which no skin wound has occurred. Or the liver may be seriously wounded by the unbroken costochondral margin through violent and marked compression of the lower thorax. (An illustration of the *chronic* effect of compression of the liver was often encountered in the days of tight corset-lacing, when parts of the right lobe of the liver were found almost amputated, sometimes retaining their connection by a mere pedicle.)

In addition to the wounds of the liver itself, damaging wounds of adjacent viscera and vessels may be encountered to complicate the liver traumatism.

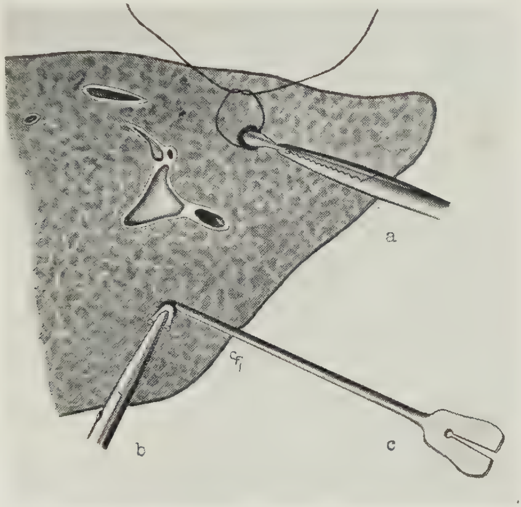


Fig. 3639.—Ligation of Severed Hepatic Vessels, Whether Divided by Wound or in Operation: — **b**, Axial clamping of the end of an exposed vessel; — **c**, freeing of its wall for ligature by combined traction with the clamp and by blunt dissection with the blunt end of a grooved director; — **a**, the partially freed vessel is being drawn out of its canal and ligated.

The most serious aspects of wounds of the liver are: — hemorrhage, infection, and special damage to neighboring vessels and viscera. Wounds may be single or multiple — and the right lobe is very much more frequently wounded than the left. Hemorrhage is the most immediate danger — and, when causing fatality, is apt to do so within the day.

Indications and Contraindications for Operation.—It may be said, broadly speaking, that immediate operation is indicated in all open wounds of the liver, — and that immediate operation is also indicated in all cases where, from the nature of the injury, degree of shock, reasonable suspicion of hemorrhage, together with pain and local intra-abdominal phenomena in the region of the liver, it is surmised that the liver has been seriously injured, though there be no actual external wound. When these phenomena are absent, or present in doubtful or minor degree, a temporizing course may be adopted.

Operation.—The special objects of operation are: — the arrest of hemorrhage, if present — the closure of the liver wound by suture or ligation, if possible (or by packing, if necessary), — and the provision of drainage if the nature of the wound and the likelihood of infection make this indicated.

The liver is exposed by one of the methods of approach already described (pp. 441–454) — as indicated by the position and nature of the special wound.

Ligation of Severed Vessels in the Liver Substance.—This technic, as in all bleeding, is, of course, the most scientific method of arrest — when the bleeding vessels are demonstrable, and the nature of the wound makes its application possible. If bleeding vessels are encountered (branches of the portal vein or hepatic arteries or veins), these are seized with ordinary hemostats, or mosquito-hemostats, end-on, so as to leave free-way for tying, and are then ligated with fine chromic catgut (Fig. 3639). The end of the vessel is sometimes so flush with the cut or torn surface of the liver that not enough of its trunk can be exposed for ligature, until it is limitedly freed by blunt dissection with a fine blunt dissector or grooved-director, as shown in the same illustration.

Simple Suture of the Incised or Lacerated Liver.—When the bleeding from an incised or lacerated wound of the liver has been controlled by ligature, it is then indicated to bring together the incised or lacerated surfaces by means of absorbable sutures — hepatorrhaphy. It may happen, on the other hand, that the incised or lacerated surfaces are not bleeding — or merely oozing, in indefinite areas — or, on the opposite hand, bleeding considerably from sources which are either unlocalizable, or, even if localizable, inaccessible. When, therefore, bleeding is absent, or insignificant, it is indicated to suture the surfaces together, as the logical step for the repair of the wound. And when bleeding is considerable, it may still be indicated (under the third set of circumstances just mentioned) to suture the surfaces together, hoping that their approximation by sutures will control hemorrhage, which it so often does, even when bleeding comes from vessels of moderate size. In all events, if ligatures cannot be applied, approximation of the surfaces is the next step in order, short of packing the wound. Simple suturing (which is to be preferred, if applicable, to the suturing reinforced by artificial devices, as described under the partial resection of the liver for tumors, p. 475) is performed in the following way: — A special blunt curved Reverdin needle, or curved, blunt Kousnetzoff's liver needle is distinctly desirable — as ordinary surgical needles tend to cut small vessels in the liver substance, and thus produce additional bleeding. Further, it is desirable that the needle should be pliable. In its passage through the substance of the liver, and to aid it in avoiding thin-walled veins instead of driving it straight ahead, from point of entry to that of exit, as in suturing most tissues, it is well to give the needle an imperceptible side-to-side motion — such as Moynihan describes as "wriggling." All fine ligatures, absorbable and non-absorbable, tend to cut the liver substance and also its vessels — and should not be used. Rather coarse absorbable material should be employed in suturing — which Kousnetzoff has shown tends to push the soft liver substance away from its course, and without cutting the vessels. The suture should, wherever possible, include a part of Glisson's capsule, which is fairly resistant, and be passed at a reasonable distance from the margins of the wound. Where the thickness of the part which is being sutured is not too great, as in wounds of the free margins of the liver, it is usually well to carry the suture through the entire substance of the liver — as shown in Fig. 3640, **c.** In other instances it may be better, or possible, to only put in surface stitches, dipping down, though, to a reasonably deep depth — as in Fig. 3640, **b.** Or one stitch may penetrate the entire part, or, at least, pass deeply, and the next stitch be somewhat more superficial — and so on. Non-marginal wounds of the liver of limited extent may be sutured as illustrated in Fig. 3641. The line of simple suturing may be reinforced by one or more mattress-sutures. More complex forms of suturing will be described under the Excision of Tumors of the Liver, p. 475.

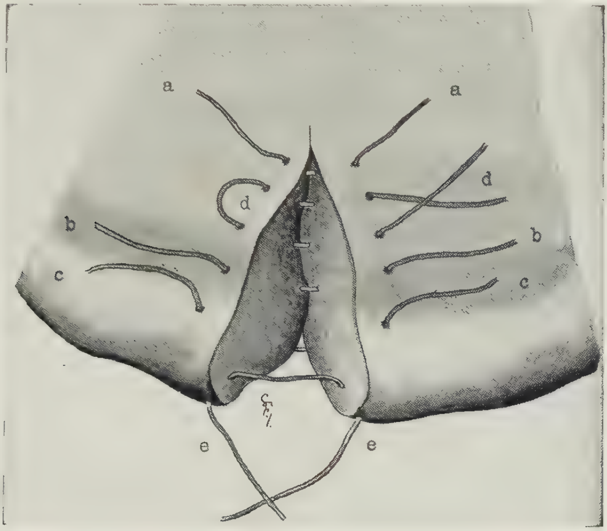


Fig. 3640.—Simple Types of Suturing of Incised or Lacerated Wounds of the Liver; _ **a, a,** Superficial suture; _ **b, b,** deeper suture; _ **c, c,** penetrating suture; _ **e, e,** marginal suture; _ **d, d,** mattress-suture.

Gauze Packing of Liver Wounds for Hemorrhage Which Cannot be Controlled by Ligature or Suture.—This is a method of last resort _ and is sometimes not only all that is left which can be done _ but is often successful in permanently arresting hemorrhage. It necessitates, of course, the temporary bringing out of the gauze pack through the abdominal wound.

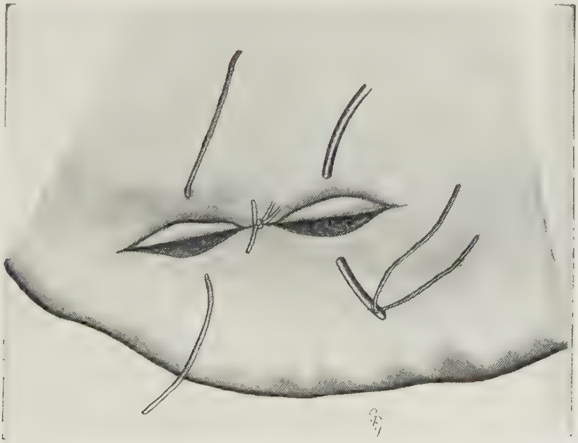


Fig. 3641.—Suturing a Non-marginal Wound of the Liver with Simple Sutures. Mattress-sutures may also be employed.

As a rule, the gauze is simply packed, as a tampon, into the depths of the wounded liver, with a fair degree of firmness _ infolded strip-gauze being the best for this purpose, as used for intra-uterine packing _ depending upon the surfaces of the wound to hold it in place. On the other hand, it is sometimes possible to construct a more safely retentive pocket for holding the gauze, which also makes it possible to pack more snugly. If the wound be from one surface of the liver, on into its depths, without passing entirely through to the opposite side, the margins of the wound, including a good bite of Glisson's capsule, is sutured up part of its way _ after which gauze strips are packed into the pocket. If the wound have passed entirely through the liver, severing opposite surfaces, it may be possible to suture up both surfaces, leaving the opening at the margin, and into this the gauze may be packed. The outer end of the gauze is then brought through the abdominal wound, which is sutured up to its site of exit.

Operative Treatment of Stab and Gunshot Wounds of the Liver.—Immediate abdominal section, in the site of the wound, is usually indicated. No certainty as to the full nature and extent of the damage is otherwise possible _ and it is doubtful whether the temporizing, sometimes advised, is ever warrantable, even when the puncture is very small or the caliber of the ball especially small. On exposing the site of injury in the liver, one of several courses may be followed, based on the presence or absence of hemorrhage, and the extent of damage, according to the individual judgment of the Surgeon, _ the wound may be sutured, packed, or drained. Any infective material encountered is removed. Simple wounds are often approximated with one or two mattress-sutures, so placed as to close the liver wound _ unless, in the absence of bleeding, the indication for drainage seems paramount.

Operative Treatment of Subcutaneous Wounds of the Liver.—These usually partake of the nature of laceration _ and are treated as already indicated.

HEPATOTOMY FOR ABSCESS OF THE LIVER

Classification of Liver Abscesses.—Various methods of classifying abscesses of the liver have been used: _ (*a*) **Anatomically,** abscesses may be: _ (1) Suprahepatic, between the upper surface of the liver and the diaphragm, and between the layers of the broad ligament, due to lymphangitis in the vessels of this region, _ (2) Subhepatic, upon the inferior aspect of the liver, and due to lymphangitis in the vessels of this region, _ (3) Intrahepatic, within the substance of the liver, and constituting the most frequent form of abscess. (*b*) **Pathologically,** abscesses may be: _ (1) Traumatic, from an open wound or contusion, resulting from infection from without, or from the blood; _ (2) Pyemic, from septic emboli, carried to the liver from other foci; _ (3) Amebic (tropical abscess), from the Amœba coli; _ (4) Abscesses from such causes as tuberculosis, actinomycosis, and hydatid cyst. Hepatic abscesses may be single or multiple. The majority of abscesses are of amebic origin and single _ and usually occur in the right lobe of the liver, and generally nearer the convex than the concave aspect of the organ. Multiple abscesses are not usually subjected to operation. Abscesses in the different regions of the liver are graphically shown in Fig. 3642.

Routes of Approach in Operating Upon Hepatic Abscesses.—The special method of approach, in individual cases, will, of course, depend upon the situation of the abscess. In the majority of cases this will have been determined in advance of operating, by either the physical signs, or by exploratory puncture (which, as mentioned under that procedure, should not be performed until all is in readiness for immediate operation, provided pus be found). Having determined upon the site of exposure by one of the methods mentioned _ or having decided upon the aspect of the liver to be exposed, without first corroborating the presence of pus by either physical phenomena or exploratory puncture _ the special method of exposure will be the one best adapted to reach the corroborated or suspected collection of pus by the safest and most direct route. The routes usually employed are the abdominal (transperitoneal) and the thoracic (either subpleural or transpleural). The details of exposing the surface of the liver have been already given under the various methods of exposure of the liver _ and will not be referred to here at any length. It will be taken for granted that the pleural cavity has been safeguarded in operating by the thoracic route _ and that the peritoneal cavity has been walled off with gauze pads in operating by the abdominal route _ and after having accomplished these ends, the technical procedures are, practically, the same, whether entering the liver through the thorax or the abdomen _ and independently of the nature of the abscess.

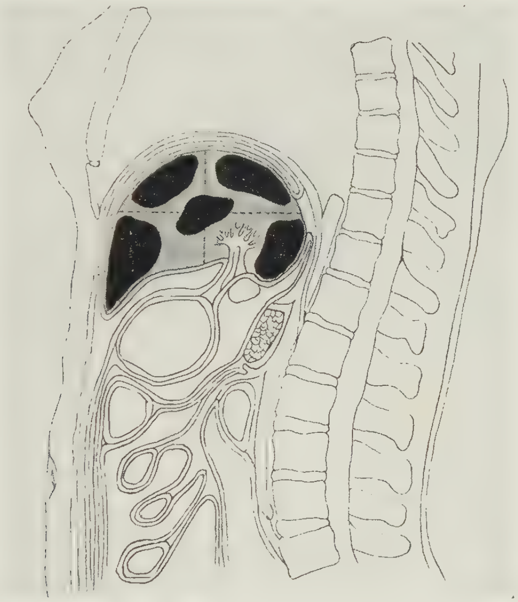


Fig. 3642.—Sites of Hepatic Abscesses: _ A, Abscess of the anterosuperior segment of the liver; _ B, of the antero-inferior segment; _ C, of the posterosuperior segment; _ D, of the postero-inferior segment; _ E, intrahepatic abscess entirely within the liver substance and not reaching its surface.

Hepatotomy, in General.—Hepatotomy consists in an incision of the liver _ and is generally resorted to for abscess, hydatid cyst, or as a step in the operation of the removal of a tumor by incision and enucleation, or, more generally, by excision. In operating for abscess the incision of the pus cavity is invariably followed by drainage. The site of the incision is usually determined in advance, either by physical signs or by exploratory puncture. If exploration by needle be made, the patient should be upon the operating-table, fully prepared for transperitoneal or transthoracic operation immediately following the demonstration of pus. The liver may be exposed by the transperitoneal, subpleural, or transpleural routes _ and each of these routes may be followed from the anterior, lateral, or posterior aspects of the thoracico-abdominal wall _ though each method of approach usually has a site of preference. The selection of the site and method of operation will depend upon the location of the abscess or other condition – as to its accessibility, importance of contiguous organs, and possibility of drainage. The choice of incision for approaching the liver transperitoneally will generally lie between the oblique subcostal and vertical subcostal incisions – each having its advantages (see General Surgical Considerations). It is to be remembered that abscesses, hydatids, tumors, etc., often project downward considerably below the ribs. It is also to be remembered that, after incision of such sacs and emptying of their contents, there is a tendency for the portion of involved liver to regain its normal position – and that, therefore, in calculating to suture such parts to the abdominal wall for drainage, calculation must be made that the stitching will not draw the part too far out of its natural position. Where no guide exists, part of one of the lower ribs in the midaxillary may be excised – or the anterior or anterolateral subcostal transperitoneal route be chosen, as, in abscess, pus is usually in the more anterior part of the right lobe. But after exposure of the liver, if, by exploratory syringe, or otherwise, pus be found in a locality more conveniently reached and drained from another external incision, the first incision may be closed and a second made in the indicated position. The different incisions described in the preceding pages are given to cover the various sites in which the liver may be exposed – and apply as much to the exposure of the liver for other purposes as for incision of that viscus. In the case of pus or hydatids the site of operation will generally have been indicated by a preliminary exploratory puncture.

The operation of exposure of the liver may be done in one or in two stages. In operating in one stage the liver is exposed and the organ is cut into at once – after safeguarding the general peritoneal cavity by suturing the parietal peritoneum to the surface of the liver, or by gauze packing, – or, in transthoracic operations, after protecting the pleural cavity on the same principles. In operating in two stages the liver is first exposed and the wound then packed with gauze for three or four days, until the peritoneal surface of the liver adheres to the wound (the union being reinforced and aided by sutures in some cases) – and then the organ is incised.

In operating transthoracically, if the pleura be wounded, it should be immediately sutured – with a purse-string suture, if possible, thus drawing the edges together. The subpleural method is generally impossible if adhesions exist – but then, also, the pleural cavity is apt to be shut off – so that it is not opened up even if one passes through its layers. The posterior superior aspect of the right lobe of the liver is fused to the diaphragm (there being no peritoneum here) – hence the diaphragm may be immediately incised in this locality without waiting for adhesions. An abscess here would be subphrenic and extraperitoneal. If the transpleural method of approaching the liver be adopted, the same principles should be adhered to as in operating transperitoneally – either suture the two opposed pleuræ together and incise through them at once – or press the two pleural surfaces into contact with gauze packing, or suture, for two or three days, until adhesions occur – and then incise through them. It is preferable to pass beneath the pleura rather than through it – and if it must be incised at once, it is preferable to suture the parietal and visceral layers together preparatory to going through them. The operation of suturing the pleuræ, however, is quite difficult – and the suturing is apt to tear away – or allow of leakage.

In cutting into the liver the incisions should be made in straight lines radiating from the direction of the center toward the periphery. Bleeding from deep incisions may generally be controlled by ligature *en masse*, with interlocked stitches – as described under partial excision of the liver.

Hepatotomy, for Abscess, by the Subpleural Route, in the Midaxillary Line, Following the Partial Excision of a Lower Right Rib.—If the site of abscess be declared by physical signs, or by exploratory puncture, this will determine the position of the incision. If, on the other hand, there be no pointer to the abscess, a good general position for making the subpleural approach is in the midlateral aspect of the right chest, between the anterior and posterior axillary lines, after the subperiosteal excision of part of one of the lower ribs, remembering that the lower margin of the right pleura is due to be encountered opposite the ninth rib on the right side (the lower border of the lung lying about two ribs higher). The rib above or below may be chosen. If an exploratory needle be first used through an adjacent intercostal space, it should be of good caliber; and about 15.3 cm. (6 inches) in length – and if the puncture first made be unsuccessful, it may have to be inserted to its full length and in several directions – the punctures being made with reference to the important anatomic structures to be avoided. Following the withdrawal of the needle, or with the needle sometimes left *in situ*, where its usage has been followed by positive result, about 5 cm. (2 inches) of the elected rib in the midaxillary line is subperiosteally excised (as described at p. 451). The posterior layer of the periosteum and the endothoracic fascia are incised. If the lower aspect of the pleura be encountered, it is detached by blunt dissection with the tip of the finger, and pushed upward, out of the way (Fig. 3643). The diaphragm is then divided in the cleavage line of its fibers. Having divided the diaphragm, one of two conditions will be encountered: – If adhesions be present, the abscess is opened at once, either by knife-cut or by dressing-forceps introduced closed, and then opened. Any bleeding which occurs here is generally controllable by finger or gauze pressure. The finger is introduced through the incision and any pocketing found within the cavity

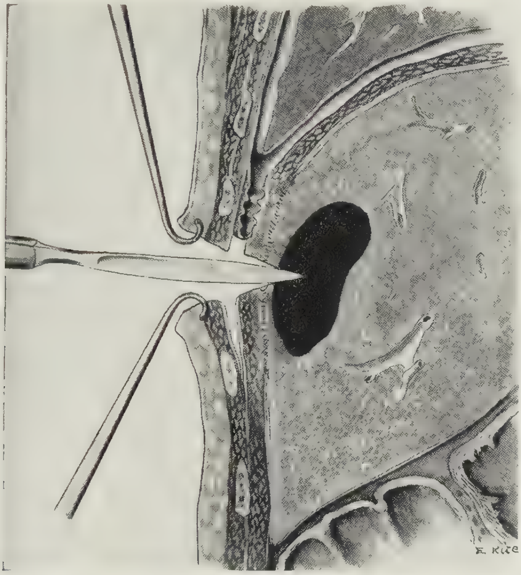


Fig. 3643.—Subpleural Hepatotomy for Abscess – in coronal section. The lower reflected pouch of parietal and visceral (diaphragmatic) pleuræ has been exposed in the bed of a partially excised rib – and has been separated by blunt dissection and pushed upward – so that the diaphragm, liver, and abscess have been entered entirely below the displaced pleural pouch.

is broken down _ after which a large rubber drainage-tube is introduced, its inner end passing well within the cavity of the abscess, and its outer end anchored to the margin of the wound with one or two catgut stitches. If no adhesions be present, the margins of the diaphragmatic opening may be stitched to the liver _ after which the abscess may be opened at once, in case of necessity (although leakage is apt to occur) _ or, preferably, if no haste be indicated, gauze is packed against the diaphragm sutured to the liver for two or three days to promote adhesions additionally _ after which the abscess is opened in the same way as though adhesions had been found at the time of operating.

Hepatotomy for Abscess by the Transpleural Route.—In operating in a region opposite the pleura, as one must do in operating posteriorly, and may even do in the axillary line, or more anteriorly, it may not be possible to free the pleura by blunt dissection and displace it upward. The site is exposed by the partial excision of one or more ribs _ and after the posterior layer of the periosteum and the endothoracic fascia have been incised, the parietal pleura is encountered. If adhesions be present, one may incise directly through parietal and visceral layers of the pleura, and the diaphragm (in its cleavage line) _ and if, fortunately, adhesions exist between the diaphragm and liver, the incision may be continued on into the liver substance (Fig. 3642, **b**). If adhesions between the layers of the pleura be absent, these layers should be sutured together around the site within which the incision is to be made, and the wound further packed with gauze for two or three days, to promote adhesions as described at p. 459 (which will often also cause adhesion between diaphragm and liver, if this do not already exist). If haste be required, the incision may be made as soon as the layers of pleura have been sutured (Fig. 3644) _ and, if the diaphragm be found unadherent to the liver, as soon as

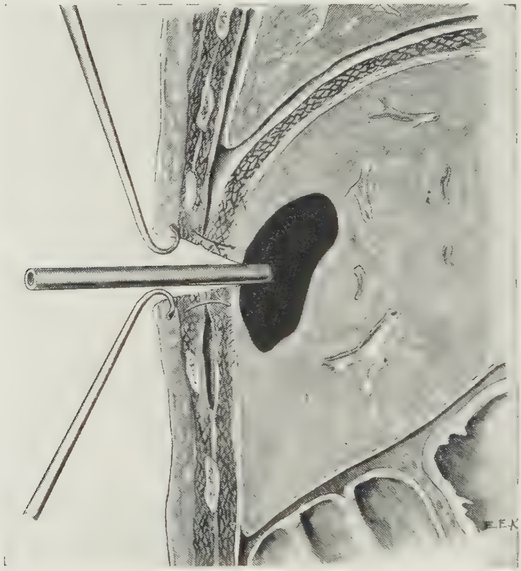


Fig. 3644.—Transpleural Hepatotomy for Abscess _ in coronal section. The area of parietal and visceral pleuræ to be incised has been surrounded by elliptic suturing. A drainage-tube has been inserted through the thoracic wound and incised liver, into the abscess cavity.

this has been sutured to the liver. Exploratory puncture may have been made immediately prior to the main operation _ and the needle may be left *in situ* as a guide to the pus cavity.

Hepatotomy for Abscess by the Transperitoneal Route.—The site of abscess is exposed by one of the methods for exposing the liver, in general, by the transperitoneal method _ preferably by oblique subcostal incision or by vertical incision. The liver having been exposed, the operation may be concluded in a single stage or in two stages: _ (*A*) In One Stage: _ Where (in pus and hydatid cases) adhesions of parietal peritoneum to hepatic peritoneum have occurred, the incision may be made directly into the liver substance. Where no such adhesions exist, one of two courses may be pursued: _ (*a*) The lips of the abdominal wound may be applied to and pressed around the site of the liver to be opened by the fingers of an assistant and by packing _ the tensity of the abscess wall is then lessened (to avoid a gush of pus) by the withdrawal of some of its contents with a syringe _ a narrow bistoury is inserted into the abscess and its walls incised (Fig. 3645) _ the contents are directed outward, without escaping into the abdomen _ and as soon as the cavity is partly empty, the edges of the abscess wall, including Glisson's capsule, are seized with special forceps and drawn up into the wound and everted, while the balance of its contents is emptied _ the borders of the abscess cavity are then stitched to the edges of the abdominal wound at its lower plane (that is, to the parietal peritoneum, subserous areolar tissue, transversalis fascia, and possibly into the edge of the muscle tissue) with continuous or interrupted chromic gut sutures _ closing in either end of the abdominal wound in the usual way _ leaving room for the exit of tube or gauze drain. Or, pursuing a second

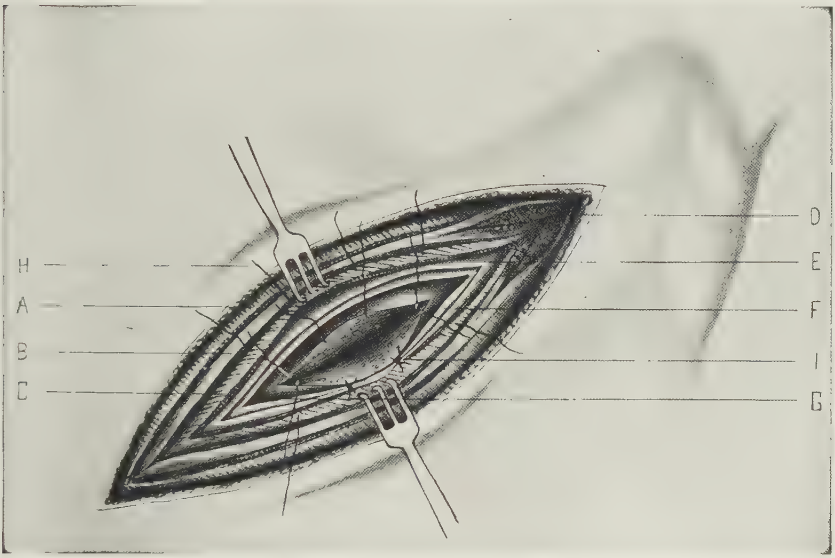


Fig. 3645.—Exposure of Liver, and Hepatotomy, by Anterior Oblique Subcostal Incision: _ A, External oblique; _ B, internal oblique; _ C, transversalis; _ D, outer border of right rectus incised, showing superior epigastric vessels between muscle and posterior sheath; _ E, transversalis fascia and subserous areolar tissue; _ F, peritoneum; _ G, surface of liver; _ H, suture through lip of liver wound, peritoneum, transversalis fascia, subserous areolar tissue, and transversalis; _ I, same tightened, approximating lip of liver wound to lower plane of abdominal wound. Muscle-fibers and nerves are both damaged in this method of approach.

course – (*b*) Before opening the peritoneum, and after recognizing that the parietal and hepatic peritoneal surfaces are not adherent, the parietal peritoneum (by slight outward separation of the extraperitoneal parts of both lips of the wound) may be stitched, with curved needle, to the hepatic surface over an elliptic area, with continuous chromic gut – surrounding and further protecting the area by gauze packing – and then incision is made simultaneously through parietal and visceral peritoneum into the liver – drainage being established and the wound treated as in (*a*).

(*B*) In Two Stages: – This method is practised only where no adhesions are found – and when no haste exists. The parietal peritoneum is united to the serous surface of the liver in one of the two above ways – the gauze packing being preferable to the stitching (or both may be used together) – the wound being packed with gauze, pressing the serous surfaces together for two or three days – after which the incision is made and the operation completed as in (*a*) above.

Operation for Hepatic Abscess by Trocar and Cannula, Followed by Siphonage Drainage.—This technic is strongly upheld by Cantlie as the operation of choice for abscesses of the liver, even when the pus cavity is deeply situated within the substance of the organ – and in spite of the popular tendency to criticize the technic as unsurgical ("whatever that may mean," he writes) as a timid, half-way measure. Moynihan quotes Cantlie's description, as follows:

"When a liver abscess is suspected, pus ought to be sought for without delay. This is done by introducing the hollow needle (not longer than 4½ inches) of an aspirating syringe, or an aspirator into the liver. If pus be not found at once, the needle may be inserted again and again – say, six or more times – into the liver in different parts.

"In my opinion the pus ought never to be sought for unless the Surgeon is prepared to operate at once should pus be found. In many hospitals and in the private practice of many physicians it is customary first to search for pus, and, should it be found, to ask a Surgeon to operate at a later date. This is a dangerous and unjustifiable procedure. If the physician wishes a Surgeon to operate, the latter should be at hand ready to do so the moment pus is discovered; for, were a thin-walled abscess near the liver surface to be pricked in one or more places by a needle, the pus might quickly escape thence into the peritoneal cavity. Even after pus is found, it is well to introduce the needle in one or two other places in the vicinity in order to ascertain the "lie" of the abscess, so that it may be drained from the lowest part. Never introduce the same needle by which pus has been found into another part of the liver, or, at any rate, do not reintroduce the needle until it has been sterilized; the reason is obvious.

"When the abscess has been found, incise the skin at the seat of the needle puncture for about ¾ inch, to admit the trocar. The trocar and cannula to be used should be not less than ⅓ inch in diameter and have a stem 4½ inches in length. Plunge the trocar and cannula into the abscess, maintaining the direction traveled previously by the hollow needle. Withdraw the trocar and stop the flow of pus through the cannula by placing the thumb over its mouth, as it is unwise, at this stage, to allow the abscess cavity to empty itself completely.

"Through the cannula introduce an india-rubber tube ½ inch in diameter and 9 inches long; this may be done by stretching the tube upon a metal rod with a small end hook at one side, in which the rubber tube is caught so that it can be stretched. The tube has, of course, several holes cut in it at the end intended to be put into the abscess. When the tube and the rod on which it is stretched touch the bottom of the abscess cavity, withdraw the cannula over the stretched tube; then allow the tube to contract toward the bottom of the abscess and remove the metal rod. The drainage-tube is now in the abscess, and some 4 or more inches project from the side of the patient's chest. The tube may be cut short, but I prefer to leave it long and to establish siphon drainage by inserting into its projecting part one end of a piece of glass tubing of suitable size and 3 or 4 inches long, the other end of which fits tightly into a rubber tube of sufficient length to reach the bottom of the bucket standing by the side of the bed. The bucket should contain enough carbolized water to cover the outlet of the tube, and into this the pus drains. A weight ought to be attached to the lower end of the tube, to prevent clipping or displacement. The operation is completed by stitching the tube to the skin where it issues from the chest, and covering the wound around it with wet antiseptic gauze.

"The subsequent treatment consists in keeping up the drainage until the fluid that issues, as seen through the glass tube, is no longer purulent or flocculent, but merely bile-stained. If at any time pain in the shoulder or side is complained of, raise the bucket off the floor until it is nearly on a level with the bed; this lessens the severity of the siphonage, which probably caused the 'drawing' pain. As pus disappears, stop drainage and shorten the tube, reducing its size as the discharge gradually ceases."

Comments.—Where the abscess, or other cavity, is incised before the abdominal wall is sutured to the liver, the suturing of the margin of the cavity to the abdominal wound is aided by inserting the left index-finger into the cavity and hooking it forward _ thus holding it in contact with the abdominal wall while the sutures are being placed and tied.

The pus is often very thick and a rubber tube of large caliber is usually indicated _ which should pass well into the pus cavity, and be anchored by one or two chromic gut sutures to the margins of the thoracic or abdominal wound.

As the liver tends to retract upward, the higher the wound of drainage can be made, the better.

Some Surgeons depend entirely upon packing off the peritoneal cavity with gauze before opening the abscess _ after first relieving the excess of tension by the aspiration of some of the contained fluid.

In walling off the area which is to be incised in the transpleural operation the continuous chromic gut suture should include the intercostal muscles, pleural surfaces, and diaphragm.

Differential pressure methods are often of value in operation through the thorax.

Drainage should not be discontinued until the discharge has practically ceased.

Manson's method of drainage (which has some good and some bad points) is as follows: The skin is limitedly incised, and a large trocar and cannula passed directly into the pus cavity, through whatever structures intervene. The trocar is then withdrawn, and a rubber tube, somewhat larger than the cannula, and tensed by being stretched over a heavy uterine sound, or slender dressing forceps (so as to lessen its diameter), is carried down the cannula, which is withdrawn while the tube is still under tension. The rubber tube, which is at once relaxed, then fills the opening entirely by its increased diameter, and, additionally, on withdrawal of the probe, exercises slight positive pressure upon the walls of the tract made for its reception _ in this way preventing leakage between the pus cavity and the skin. No knowledge or examination of the intervening structures is possible in this method _ nor examination of the pus cavity, and digital breaking up of pockets – nor certainty as to leakage during the actual technic. The method, however, has yielded good results.

x-Raying may furnish valuable guidance in locating hepatic abscesses.

Exploratory puncture of the left lobe of the liver is too dangerous to be employed. Such abscesses are usually best exposed by a vertical epigastric incision.

A low, posterior abscess is generally best approached by a lumbar incision, below the twelfth right rib.

Upward extending abscesses are best approached by the subpleural or transpleural route.

Anterior abscesses are usually approached by the abdominal route.

The technical procedure of exploratory puncture is more readily as well as more safely performed if the liver be first exposed.

In operating through the peritoneal cavity, all surrounding structures should be well protected by gauze packing. When the abscess has been excised, its opening may often be brought into more convenient position for manipulation, by hooking the finger in the pus cavity and drawing the organ forward.

The deep-lying abscesses located after exposure of the liver, instead of cutting through the thick layer of intervening liver tissue, the needle is often left in position and, upon this as a guide, a pair of slender dressing forceps is carried into the pus cavity – after which the blades are opened in the act of withdrawal, thus separating the liver tissue by blunt rather than sharp dissection, with correspondingly less hemorrhage. A rubber tube is then carried down with the same forceps as a drain.

If considerable hemorrhage occurs from the division of large hepatic vessels it will sometimes cease with temporary plugging of the wound with the finger – or gauze packing may be required. Ligation of any visible vessel is, of course, preferable.

If the liver have not been sutured to the abdominal wall before the abscess is incised, it is usually sutured to margins of the wound after the abscess is opened.

Sometimes no effort is made to anchor the liver to the abdominal wall, when there is a direct free-way from liver to surface – and, in the case of abscesses opened upon the under surface of the liver, anchorage is usually impossible. In these cases the rubber drain serves to bridge the intervening way, with or without additional gauze packing around it. Adhesions, especially by the omentum, usually rapidly form and protect the avenue of drainage.

Where some distance has to be spanned between the liver abscess and the overlying abdominal wall, there is no objection to the anchorage of the rubber drain both into Glisson's capsule, and into the abdominal wound, by means of catgut sutures, which will eventually be dissolved, thus liberating the tube.

In all methods whereby the liver surface is sutured to the overlying thoracic or abdominal wall, provision should be made that the stitches be so placed as not to likely tear out upon the return of the liver to its natural position – and this is particularly the case in operating through the abdomen, remembering that the liver markedly tends to be drawn upward following operation – to say nothing of its tendency to be drawn away from the abdominal wall in the convalescent dorsal decubitus of the patient.

If exploratory puncture be used, the needle is entirely withdrawn before being carried into a new direction.

Taylor suggests that the rubber tube drain should have a diameter of

1.9 cm. (¾ inch), but this seems rather excessive. Two parallel tubes are also sometimes used – but with two tubes it is more difficult to prevent leakage.

While some Surgeons flush the abscess cavity, the majority do not.

While the pus of tropical abscesses is, generally, sterile, ordinary pyogenic bacteria are apt to subsequently enter and complicate matters. Extreme care should be used to avoid this.

The abscess is sometimes opened by the actual cautery after the liver has been exposed – but the method does not seem to have a great deal to recommend it.

Zancarol and Fontan have advised curetage of the abscess cavity – and there may be cases in which this technic, carefully carried out, might be advisable.

One may usually count on keeping free of the pleura, in excising a rib in the anterolateral aspect of the chest if it be within 5 cm. (2 inches) of the costal border.

While multiple abscesses are regarded as contraindication to operation, if one be operating upon a single abscess, and a second abscess be found nearby, the second cavity can often be drained through the first by breaking down or cutting through (preferably the former) the intervening tissue.

The drainage-tube should fit the opening in the liver snugly to prevent leakage – or the excess of this opening should be closed by sutures through Glisson's capsule. The portion of the tube well within the abscess cavity should be fenestrated – but no lateral openings should exist in that portion of the tube intervening between the liver surface and the skin.

While the exploratory needle which has located an abscess through an intercostal space is often left *in situ* as a guide to be cut down upon, it is generally not thus left in exploring through the abdominal cavity, for as soon as the liver is exposed by abdominal section, the needle wound into the liver is usually plainly evident in the field.

In operating low down in the scapular line the pleura will necessarily be encountered, and instead of surrounding the area to be incised with an elliptic suture one sometimes divides the parietal pleura, then similarly divides the diaphragmatic pleura and sutures the free edges of the two together – thus completing closing off the general pleural cavity and making it possible to operate below the level of the artificially shortened pleural space.

General protective adhesions will often be favored, after inserting the rubber drain, by the packing of the vicinity with gauze, exercising sufficient pressure to compress the thoracic or abdominal wall against the site of exit of the drain from the liver.

Frequently the hemorrhage from the incised liver, between liver surface and abscess, will be checked by the pressure of the rather large-size drainage tube introduced.

The usual sites for making exploratory punctures for pus cavities within the liver are considered under Exploratory Puncture of the Liver, p. 440, and also under the operation by trocar and cannula, p. 464.

Briefly stated – liver abscess should be treated by early evacuation and free drainage. And if exploratory puncture precede the major operation, all should be in readiness for the immediate performance of the latter, in the event pus be found (to prevent infection of pleura or peritoneum, and to avoid losing the direction secured through exploration).

In most instances the majority of Surgeons will carry on the operation to completion at one sitting, rather than temporize and await adhesions. If a suction apparatus be present, much of the pus can be withdrawn from the cavity with almost perfect safety. In this method of procedure an exploratory trocar and cannula are used (or needle of a suction syringe) – and when pus is located the suction apparatus is attached to the cannula or needle without withdrawal of the latter. The abscess cavity is then not incised until practically all pus has been withdrawn and no further tension exists.

OPERATIONS FOR ECHINOCOCCUS CYSTS OF THE LIVER

The methods usually employed in the treatment of hydatid are the following: –

(*a*) Puncture, with or without the injection of some bactericidal agent – now practically never done.

(*b*) Anchorage, incision and drainage of the sac – probably the most commonly employed method of treatment. The technic is the same as employed in dealing with abscesses.

(*c*) Incision, clearing out the contents of the sac, followed by suturing up the sac from within (as in endo-aneurysmorrhaphy, I, p. 53), to promote its obliteration – rarely performed.

(*d*) Excision of the entire echinococcal sac – the most radical of all measures. The technic is practically the same as used in excising solid tumors (described at p. 476).

To summarize, the best methods of treatment are – either, incision, with evacuation of the endocyst and daughter cysts (in one or in two stages), with drainage – or enucleation.

OPERATIONS FOR CIRRHOSIS OF THE LIVER, IN GENERAL

In cases of ascites, due to some forms of cirrhosis of the liver – in which, formerly, frequent tappings were the only available surgical measures – technical procedures have been worked out, and sometimes successfully employed, based upon forming additional venous communications between the systemic and portal circulations, in order to relieve obstruction in the overburdened portal circuit. The method of accomplishing this is usually brought about by suturing the omentum to the anterior abdominal wall to form adhesions, and by frictioning or roughening the convex surface of the liver and spleen, for the purpose of causing their adhesion to the parietal peritoneum to bring about new vascular channels. Ito has suggested frictioning the mesentery and intestines for the same purpose.

The chief channels of communication between portal and systemic circulations available for this purpose are the following: – The accessory portal system of Sappey, between the portal, on the one hand, and the mammary and epigastric systems, on the other, – the anastomosis between the esophageal and gastric veins, – the communication between the hemorrhoidal and inferior mesenteric veins, – and the veins of Retzius, which communicate between the intestinal and mesenteric terminals of the portal vein, and the inferior vena cava and its branches.

The forms of cirrhosis in which operation has been employed (modified from Moynihan) are the following: – Atrophic cirrhosis of the liver (of which the most common group is due to alcohol, and usually occurs in middle life – and a second group, supposed to be due to various toxins, generally encountered in young adult age), – cirrhosis resulting from heart disease, – pseudocirrhosis, associated with chronic pericarditis, – chronic hyperplastic perihepatitis, – portal stenosis due to thrombosis (rare).

Drummond and Talma proposed the operation independently of each other – and Morison operated for Drummond.

OPERATION FOR CIRRHOSIS OF THE LIVER

BY THE TALMA-DRUMMOND-MORISON TECHNIC

Description.—The accessible convex surfaces of the liver and spleen are frictioned, so as to form adhesions with the corresponding frictioned surfaces of the diaphragm _ after which the frictioned omentum is sutured to the frictioned parietal peritoneum _ for the purpose of establishing additional communications between the systemic and portal circulations, so as to relieve obstruction in the portal circulation.

The procedure, as performed at present, has sometimes, though wrongly, been described under the title of omentopexy or epiplopexy _ which now constitutes but one portion of the total technic.

Preparation _ Position _ Landmarks.—As for abdominal section in or near the median line (usually in the linea alba).

Anesthesia _ Analgesia.—The operation is sometimes performed under the latter. In the writer's judgment the former is preferable, as many square inches of surface are involved in the fullest type of operation.

Incision.—The incision is made in or near the median line _ over a length equivalent to that between the ensiform cartilage and the umbilicus.

Operation.—The amount of peritoneal (ascitic) fluid encountered on opening the abdomen will depend upon circumstances _ but all of this must be evacuated _ by depressing the abdominal wall, by sponging, or by suction drainage _ until the depths of the pelvis and of the renal regions are entirely free. None should be left. The liver is exposed and examined and all its convex surface which is accessible, and which comes into contact with the diaphragm, is briskly frictioned with gauze stretched over the fingers _ and the corresponding concave surface of the diaphragm is similarly treated. The accessible convex surface of the spleen (which is always enlarged), and the corresponding concave surface of the diaphragm are also frictioned in the same way. Thus, adhesion between convex surface of liver and of spleen, and concave surface of diaphragm over a comparatively large area, is favored. This frictioning must not be carried on to the degree of traumatism.

Having thus prepared the way for hepatodiaphragmatic and splenodiaphragmatic adhesions, the omentum is now brought forward into the abdominal wound. Owing to the overdistention of the abdominal wall, in the average case, its now relaxed state enables the two margins of the wound to be well everted _ and, while so held, in turn, the omentum is sutured, with chromic catgut, to the parietal peritoneum, so far from the median line, on each side, as possible _ as shown in Fig. 3646. First, a preliminary line of continuous suturing is placed as far lateralward from the middle line as can be reached _ and then the omentum is tacked to the parietal peritoneum in a number of points between the outlying lines of continuous suturing and the median line. The greater the number of areas of anchorage and subsequent adhesion between omentum and peritoneum (both of which may be frictioned in advance of the suturing), the better.

The abdomen is closed _ no drainage being now employed, as was formerly the case.

Comments.—While the use of dry gauze stretched over the Surgeon's fingers will generally suffice to produce sufficient irritation, by friction, to promote subsequent adhesion between the peritoneum-covered surfaces, the writer once frictioned the convex surfaces of the liver and spleen, and the corresponding concave surfaces of the diaphragm, not only with dry gauze, but with a dry nail-brush, such as used in preparing the hands for operation, with moderately firm bristles _ and also with the fine teeth of a Doyen saw blade, held detached, in the hand. (Improvement followed the operation, the patient having an easy convalescence, and returning home _ but died within the year.) This technic has been several times employed.

Moynihan states that the mortality from the operation is probably now no.tmore than one-fourth of that formerly reported by Greenough (which was 295 per cent.) _ and that the most favorable cases for operation are those where the liver is enlarged, rather than atrophied, and where perihepatitis is present _ and the most unfavorable, those in bad condition from complicating diseases, or in whom the functional activity of the liver cells is markedly reduced. Montprofit's collection of cases showed a mortality of 20 per cent. out of 224 cases.

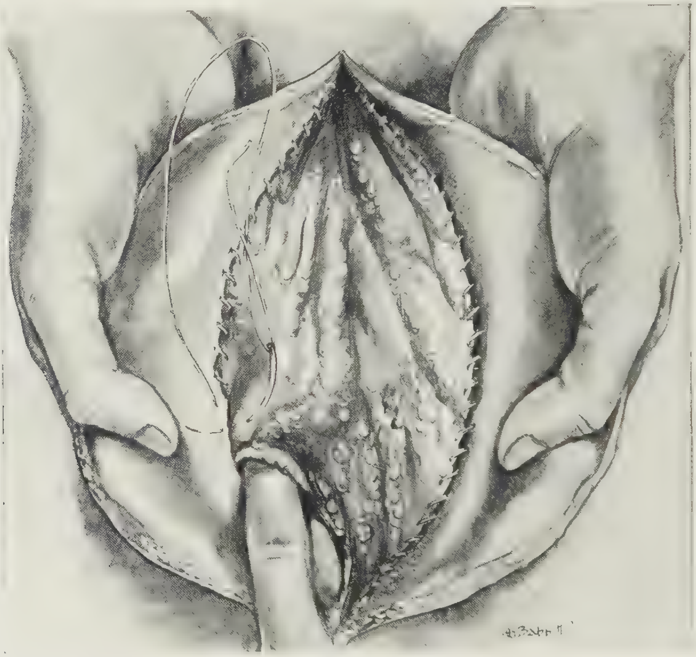


Fig. 3646.—Operation for Cirrhosis of the Liver by the Talma-Drummond-Morison Technic; _ The omentum is being sutured to the parietal peritoneum as far to each side of the line of incision as possible _ the relaxed abdominal wall being everted for that purpose. A finger within the abdomen safeguards the intestines during the suturing.

The operation above described constitutes an intraperitoneal fixation of the omentum, as compared with the extraperitoneal fixation, Schiassi's operation, next to be described.

(One of the author's oddest surgical experiences occurred in connection with the performance of the Talma-Drummond operation, in the case of a male individual, suffering from alcoholic cirrhosis of marked type: _ After opening the abdomen in the median line, the upper surface of the liver and spleen, and the corresponding dome of the diaphragm, were frictioned with gauze, upon the fingers _ with the bristles of a dry, sterile nail-brush _ and with the teeth of the blade of a Doyen saw, held in the hand _ with avoidance of all damage other than superficial de-epithelization _ and, on closing the abdomen, the frictioned omentum was sutured to the frictioned anterior parietal peritoneum. These facts probably reached the ears of the patient's wife, in detail _ and may have carried unnecessary forebodings to the lay mind, suggestive of rather harsh and unusual procedures _ fully warranting, if not inviting, the expectation of death. Be that as it may, within twenty-four hours, the expectant, unwilling _ or would-be _ widow went into full mourning _ even visiting her husband in her weeds _ and actually bought his coffin _ in preparation for what must have seemed to her an inevitable certainty! Convalescence, nevertheless, went on rapidly and favorably _ until speedy recovery enabled the patient, while still in bed, to send to his home State for a specially fat 'possum, and some yam-sweet-potatoes _ and, one nearby evening, at a neighboring restaurant, celebrated his recovery with a few faithful attendants, and the writer! The last heard of the patient, after the lapse of approximately a year, was the report of marked improvement over the former status, in which he had been frequently "tapped.")

OPERATION FOR CIRRHOSIS OF THE LIVER BY EXTRAPERITONEAL OMENTOPEXY

SCHIASSI'S TECHNIC

Description.—Instead of establishing communications between the systemic and portal circulations by intraperitoneal anchorage of the omentum, Schiassi has carried out an extraperitoneal fixation of the omentum _ Schiassi, Pascale, and Tiesche considering the extraperitoneal preferable to the intraperitoneal operation.

Schiassi's Operation.—Various modifications of the Schiassi technic have been employed _ the procedure as carried out by the Mayos, quoting from Johnson, is as follows: _ Beginning at the costal margin, incise vertically downward through the rectus, and in line with the epigastric and internal mammary vessels, for 10 cm. (4 inches) _ at the lower end of which a transverse incision is carried through the rectus, toward the median line. The vertical portion of the incision passes through skin, fascia, aponeurosis, muscle, and peritoneum, into the peritoneal cavity. The transverse incision passes through skin, fascia, aponeurosis, and rectus, but not through the posterior rectal sheath. The rectangular flap thus outlined, consisting of skin, fascia, aponeurosis, and rectus, is raised by blunt dissection from the posterior layer of the rectal sheath, and turned upward and inward. The omentum is drawn out of the abdomen, through the vertical incision which entered the abdominal cavity, and is spread out over the triangular area between the posterior layer of the rectal sheath, and the displaced rectus muscle, and is anchored by sutures. Turning the triangular flap back into place, the transversely divided rectus is then repaired by suturing _ and the vertical and transverse wounds closed by tier suturing, without drainage. To give a wider expanse of anchored omentum for anastomotic circulation, the same procedure may be used on both sides of the median line.

Another modification of the Schiassi operation, mentioned by Johnson, is as follows: _ An incision is made through the abdominal wall, in the median line, and from 5 to 7.5 (2–3 inches) in length. On each side of the median opening the connective tissue between the skin and the rectal sheath is undermined by blunt dissection in the areolar plane. The omentum is then drawn out and tucked into the flat pockets thus provided for it, one on each side of the median line, where it is anchored by suturing. The peritoneum is then sutured snugly, but not constrictingly, around the omentum, at its site of fan-like emergence from the peritoneal cavity _ and, following this, the aponeurosis is similarly sutured _ after which the skin is sutured, without drainage.

Comments.—Hernia is one of the dangers of the extraperitoneal anchorage of the omentum _ as well as the catching and strangulation of coils of intestine over the broad band of omentum drawn through the abdominal wall.

In operations for cirrhosis the period of convalescence in bed should be prolonged, to give time for the firm attachment of the structures in their new positions.

HEPATOPEXY FOR HEPATOPTOSIS

Description.—Hepatopexy consists in the fixation, by suturing, of the prolapsed liver into its approximately normal position _ the anchorage usually being to the anterior abdominal or thoracico-abdominal wall. A single lobe of the liver or the whole organ may be displaced. The organ may be found in the pelvis. Sometimes the displacement of the liver is but part of a general abdominal ptosis (Glénard's disease) _ a condition rarely subjected to operation.

Various methods of anchorage have been employed, differing in details _ the general principle being illustrated in the technic about to be described.

Operation.—The prolapsed liver having been exposed, the lobe involved in the prolapse, or the whole liver, if involved in its entirety, is brought into its normal position _ and is then sutured with coarse chromic gut, kangaroo-tendon, or silk, to the posterior surface of the anterior abdominal wall. It may also be sutured to the round ligament _ to the cartilages of the ribs _ or to the general abdominal wall. The sutures are carried deeply into the liver substance with a large, curved needle.

The suspensory ligaments of the liver may also be shortened. Sometimes the convexity of the liver is frictioned, to add the sustaining effect of adhesions.

The liver may be exposed by an oblique incision, parallel with the costal margin, and about 5 cm. (2 inches) below it, or by a vertical incision carried downward from the costal arch. The procedure is sometimes made easier by placing the patient in the Trendelenburg position. The liver is replaced by hand into its normal position. The skin is mobilized in the connective-tissue plane, over the costal arch, so that the costochondral margin is exposed. A comparatively coarse suture material is employed _ silk being used by many Surgeons _ and absorbable material being especially condemned by Kocher. In Franke's operation the liver is now suspended, sling fashion, by a double-threaded loop of stout silk, which penetrates the entire thickness of the anterior aspect of the liver in two places, avoiding the gall-bladder _ in the following way (as suggested in Fig. 3647): _ Employing a Kousnetzoff needle, the looped end of the double suture is carried from the upper to the under surface of the right lobe, as far to the right as possible, and at some distance from the free margin (4 to 5 cm., or $1\frac{9}{16}$–2 inches behind this margin). Here the needle is released, leaving the loop upon the under surface of the liver. The curved special needle, empty, now enters the under surface of the liver, to the left of the gall-bladder _ passes just far enough above the gall-bladder, in the parenchyma of the liver, to safely miss it, to emerge to the right of the gall-bladder, catch the loop, and withdraw it along the course of the needle puncture. The needle now passes from the upper to the lower surface of the left lobe of the liver, bringing the loop out upon the upper surface _ where the loop is divided, making two free suture ends emerging over the outer aspect of the right lobe _ and two similarly emerging over the left lobe. Thus the whole of the embraced liver, exclusive of the gall-bladder, is suspended in a double loop of silk. By means of a Reverdin needle each of the four free ends of suture are now drawn through all the tissues of the thoracico-abdominal wall, except the skin – in such a way that the two uppermost limbs of each double suture pass, respectively, immediately above the costal arch, the inner, in the sixth intercostal space, near the sternum, and the outer, in the ninth or tenth interspace, at the outer limit of the costal arch (Fig. 3648). The two lowermost limbs of the corresponding sutures pass through the tissues immediately below the costal arch – after which they are tied with the uppermost ones, over the costal arch – the tying being done while the liver is pressed up against the diaphragm, and during the ascent of the diaphragm (in expiration).

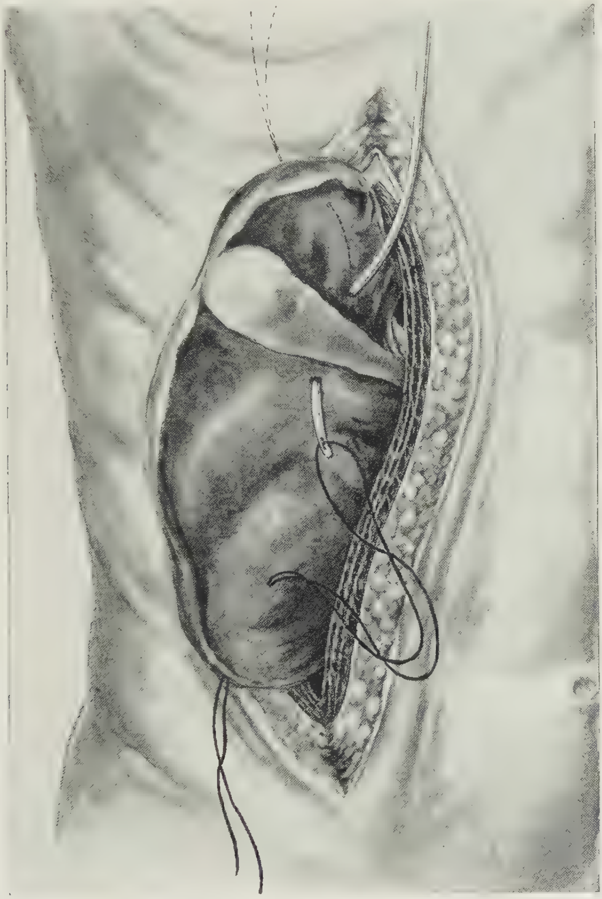


Fig. 3647.—Hepatopexy for Hepatoptosis by Franke's Method – I; – Transfixing the liver with double-loop suspensory sutures by means of a Kousnetzoff needle – avoiding the gall-bladder.

In order to decrease the possibility of cutting the liver substance with the suture, the double suture may be knotted at each site of entering and leaving the liver.

If greater security be desired, a second double-threaded loop may be passed, anteriorly to the first one.

The abdomen and skin are then closed as usual. The patient should remain in bed, upon his back, with the foot of the bed slightly elevated, for a prolonged convalescence, extending, according to some, over three or four weeks.

Comments.—Kocher advises taking advantage of any resistant, fibrous areas upon the liver substance, as often made by corset pressure, to afford resistant anchorage for stitches. He also advises laying strips of gauze, wrung out in 5 per cent. carbolic acid, between the stitches, closing up the abdomen to the exit of the gauze, and allowing these strips to remain in place for from eight to fourteen days, to increase adhesions. A supporting belt is worn for some time after the patient is up.

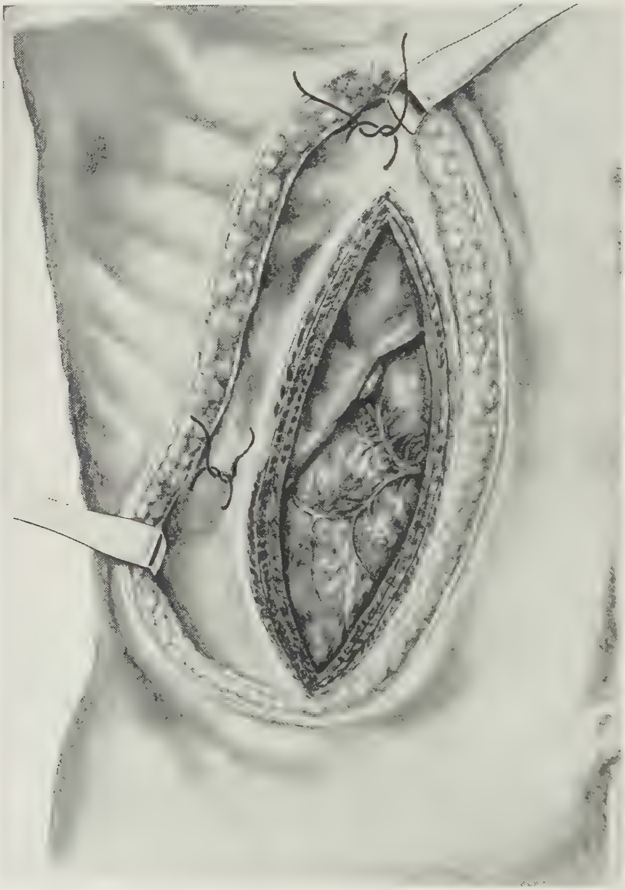


Fig. 3648.—The Same _ III; _ Tying the sutures around the costal margin.

In cases of complete hepatoptosis, Legueu suspends the organ, sling fashion, by strong looped sutures passing through its whole thickness. Péan's method consists in constructing an artificial diaphragm from the peritoneum below the liver. Dépages practices hepatopexy, and, at the same time, excises part of the abdominal wall, to overcome the relaxation.

PARTIAL HEPATECTOMY

FOR THE REMOVAL OF TUMORS OF THE LIVER

Classification of Liver Tumors (Thoele); – (*a*) **Cystic Tumors;** – Hydatid echinococcic cysts, – alveolar echinococcic cysts, – lymph cysts, – blood cysts, – cystadenomata. (*b*) **Solid Tumors;** – (1) **Benign,** – Fibromata, cavernous angiomata, – adenomata. (2) **Malignant,** – Primary liver cancer, – primary gall-bladder cancer, – secondary liver cancer, – liver sarcoma (primary and secondary),.

Most of the tumors of the liver encountered are secondary carcinomata – and, in consequence, are never or but rarely subjected to operation. Simple cystic tumors, adenomata, angiomata, and primary carcinomata are frequently operated upon.

Hemorrhage Control During the Removal of Tumors of the Liver.—Safeguarding the patient against dangerous loss of blood during the removal of liver tumors constitutes, by far, the major problem of the entire procedure. If this can be assured, large portions of the liver can be removed – indeed, as much as one entire lobe of the liver has been excised – even the right lobe, with recovery.

Classification of Methods of Hemorrhage Control in the Excision of Liver Tumors (Modified from Thoele):

(*a*) **Preliminary Preventive Measures:** –

1. Digital compression of the parts.
2. Compression of the aorta and clamping of the hepatoduodenal ligament.
3. Elastic constriction of the part.
4. Application of spring-clamps.
5. Preliminary ligation of the chief branch of the hepatic artery and vena portæ in the liver hilus.
6. Injection of suprarenal preparations.

(*b*) **Direct Measures Against Bleeding During Operation:** –

1. Thermic methods, –
    - (*a*) Paquelin cautery.
    - (*b*) Hot-air cauterization.
    - (*c*) Hot steam.
    - (*d*) Hot water.
2. Tamponage.
3. Suturing of the omentum to the liver wound.
4. Vessel ligaturing.
5. Liver suturing.
6. Mass compression of the liver stump.

(*c*) **Permanent Preventive Measures:** –

1. Mass compression methods, –
    - (*a*) Elastic permanent ligature.
    - (*b*) Permanent clamps (prolonged usage).
    - (*c*) Magnesium plate suture and similar devices.
2. Ordinary non-hard-tied mass ligature.
3. Fast-tied intrahepatic mass ligature.
4. Preliminary permanent ligation of the vessel branches of one side, at the hilus, before the excision of an entire lobe of the liver.

Conjoint Classification of Methods of Hemorrhage Control and Methods of Tumor Excision in Operating Upon the Liver (modified from Thoele): –

- (*a*) **Thermic Methods:**—
    - 1. Paquelin cautery.
    - 2. Hot-air cautery.
- (*b*) **Tamponage.**
- (*c*) **Suturing Omentum to Liver Wound.**
- (*d*) **Vessel Ligaturing and Vessel Acupressure**
    - 1. Followed by suturing of the liver wound—with
        - (*a*) Intraperitoneal treatment of the liver stump.
        - (*b*) Extraperitoneal treatment of the liver stump.
    - 2. With tamponing of the liver wound—and with
        - (*a*) Intraperitoneal treatment of the liver stump.
        - (*b*) Extraperitoneal treatment of the liver stump.
            - (*m*) First, resection of the tumor, then, fixation of the tumor.
            - (*n*) First, fixation of the liver, then, resection of the stump.
    - 3. By suture and tamponade of the liver wound.
        - Intraperitoneal treatment of the stump.
- (*e*) **Liver Suturing:**
    - 1. Intraperitoneal treatment of the stump.
    - 2. Extraperitoneal treatment of the stump—after resection.
- (*f*) **Compression by Means of Elastic Tubing, Gauze Strips, Clamps Left in Situ, Metal Plates, Sutured-on Gauze Compresses—with the Abdominal Wound Sutured Together Up to the Exit of These:**
    - 1. Single-stage operations:
        - (*a*) Intraperitoneal treatment of the stump.
        - (*b*) Extraperitoneal treatment of the stump.
            - (*m*) First, tumor resection, then, stump fixation.
            - (*n*) First, liver fixation, then, tumor resection.
    - 2. Two-stage operations (extraperitoneal fixation).
- (*g*) **Mass Ligaturing Without Fast Constriction:**—
    - 1. Intraperitoneal treatment of the stump:
        - (*a*) With suture of the liver wound.
        - (*b*) With tamponing of the liver wound, and attachment of the omentum.
        - (*c*) With suture and tamponade of the liver wound.
        - (*d*) Without suture or tamponade of the liver wound.
    - 2. Extraperitoneal treatment of the stump:
        - (*a*) First, tumor resection, then stump fixation.
        - (*b*) First, fixation of the liver, then tumor resection.
            - (*m*) Single-stage operation.
            - (*n*) Two-stage operation.
- (*h*) **Systematic Fast-constricting Mass Ligation.**
- (*i*) **Preliminary Ligation of a Branch of the Hepatic Artery and Vena Portæ before Resection of an Entire Lobe of the Liver.**
- (*j*) **Other Methods.**

It will be seen, from the above, how very considerable is the problem of hemorrhage control, in operating for tumors of the liver—to say nothing of other aspects of the procedure. Tumors which are primary and single are frequently successfully removed—whereas the removal of secondary and multiple tumors is generally not undertaken.

V-shaped Excision of a Tumor of the Free Margin of the Liver.—The simplest conceivable type of excision of tumor of the liver is where a tumor of small size involves the anterior free margin of the liver—in which a wedge-shaped piece of the border of the liver, including the growth, is removed — followed by ligature of the bleeding vessels in the liver substance, and the suturing of the margins of the wound in the liver substance, either by sutures passing entirely through the organ, as shown in the operative treatment of wounds of the liver, p. 454 — or by alternate deep and superficial sutures, as seen in Fig. 3649.

The **method of the Mayos** — as described by them (Keen's Surgery) is as follows: — "Personally, we have found the following combination simple and safe. If the portion to be excised is thin, it is crushed with forcep and then cut away with the knife, followed by a hot, moist compress, which is held on the bleeding surface. With catgut on a round needle the liver margin is quilted back and forth. As much as possible of the gap is closed by sutures, and a pad of gauze of sufficient size to fill the remainder is introduced and the liver firmly compressed upon this by catgut sutures which produce sufficient tension to check the hemorrhage. As it loosens, the gauze is removed, from the sixth to the twelfth day."

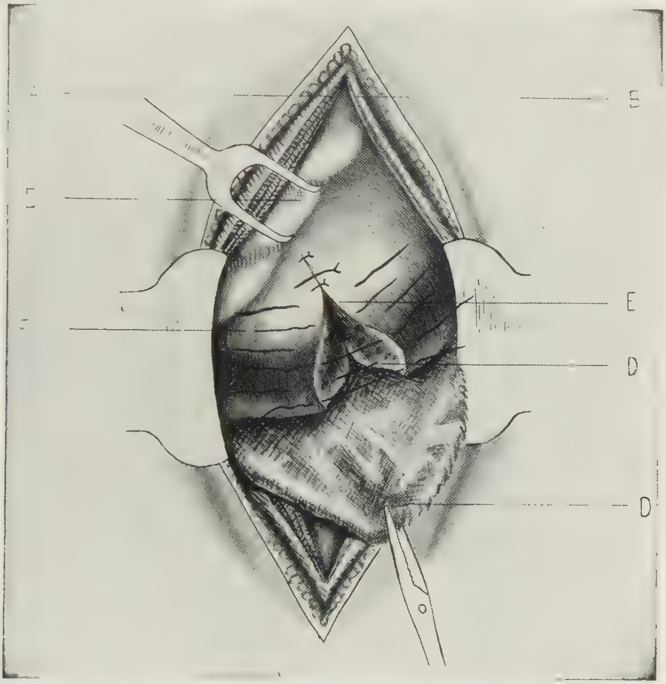


Fig. 3649.—Partial Hepatectomy Followed by Hepatorrhaphy for Tumor: — A, Incised external oblique, internal oblique, and transversalis; B, incised outer border of rectal sheath; C, costal arch retracted from liver; D (lower D), gauze pad packed under liver; E, borders of liver wound after excision of wedge; F, superficial sutures through liver substance; D (upper D), deep sutures.

Elliptic Excision of a Small Tumor from the Surface of the Liver.—The growth is circumscribed by an elliptic incision — the elliptic outline, upon the surface of the liver, representing the base of a wedge, the sides of which, left after the wedge is excised, coming together within the liver, beyond the part to be removed. The ellipse, where possible, is made with its long axis radiating from the center of the liver toward the periphery, and so placed as to avoid the chief hepatic vessels. This area is excised by cutting down along the outline of the incision, the knife traveling at a right angle to the surface, and then obliquely, so that the incisions of the two sides meet beneath the tumor. All severed vessels which are isolatable are ligatured with catgut. The sides and margins of the wound are then brought together by alternate deep and superficial sutures of chromic catgut. Sometimes the area to be excised is first surrounded by a tier of deeply placed, interlocking chromic catgut ligatures, drawn tightly enough to control the vessels which will be cut by the lines of excision.

If control of bleeding be difficult, it would seem that a modification of the "pocketing" method of Kousnetzoff and Pensky, as applied to wedge-shaped excision along the free margins of the liver, might be applied to elliptic excisions from the surface (of wedge-shaped portions of the liver substance) _ namely, the partial suturing up of both ends of the liver wound, so as to make a retentive pocket, capable of holding gauze packing _ which, applied under some pressure, will, ordinarily, control bleeding.

Excision of Liver Tumors After the Application of Kousnetzoff and Pensky's Interlocking Ligatures (Fig. 3650).—The feature of this technic is the preliminary surrounding of the field of excision by a specially applied form of interlocked suture, which, when tied, controls the flow of blood into the part. A needle of the Kousnetzoff pattern, or a dull-ended Reverdin needle is employed _ and stout silk is used. At a safe distance distal to the line of incision, and following that line, sutures are passed entirely through the substance of the liver, from the upper to the under surfaces. Beginning near one outer limit of the area to be blocked, a loop of the ligature, with equal ends, is carried through the liver, from above downward _ after which it is cut, crossed, and tied, slowly and firmly compressing the included liver. The needled end of the ligature is then carried back through the liver, from below upward, and one limb of the ligature cut, and is tied to the end left above, on the first passage of the looped ligature. The ligature is then carried through the liver the third time, from above downward, when one limb is cut, and tied to the free limb, left on the second passage, after being crossed with it. And this order of procedure is carried on until the free margin of the liver at the opposite end of the to-be blocked area is reached.

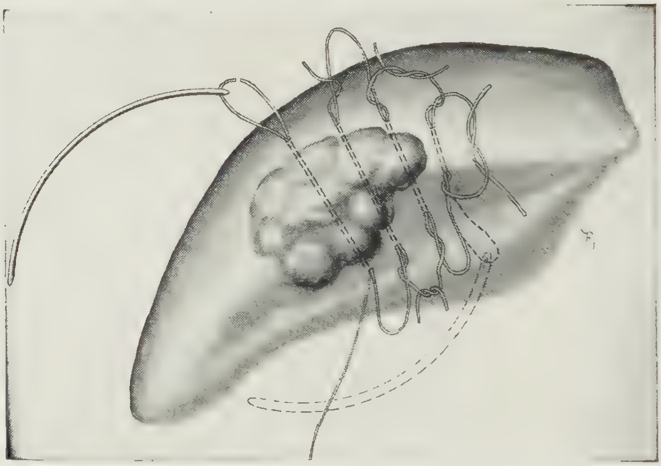


Fig. 3650.—Excision of Liver Tumors After the Application of Kousnetzoff and Pensky's Interlocking Ligatures; _ As detailed in the text.

Excision of Liver Tumors After the Application of Auvray's Interlocking Ligature (Fig. 3651).—This technic represents another one of the group which has, in common, the preliminary surrounding of the area to be excised, including the tumor, with some form of interlocking suture, which is tightened, to the extent of controlling blood-flow, prior to the act of excision. A dull-eyed needle of the Reverdin, or Kousnetzoff type, threaded with stout silk, is used. Selecting a midpoint, back of the area to be excised, the double ligature is carried from upper to lower surface of the liver _ after which the loop is cut at the needle. The two limbs of the ligature are intertwined upon themselves _ after which one ligature henceforth travels to the right, and the other to the left, from the middle point of entry. The ligatures are so drawn that one pair of ends represent shorter lengths _ and remain constantly upon the upper surface of the liver _ while the other pair of ends are the traveling or transfixing ends. The empty needle is now passed through the liver at a point to one side of the midpoint, about 1 cm. ($\frac{7}{16}$ inch) distant _ catches the free limb of the ligature and draws it through the liver, where it is tied with the upper end, by a single knot, at first, which is slowly tightened, cutting its way through the substance of the liver, until the vessels are constricted, but not cut, after which the second phase of the knot is tied. The unthreaded needle is now passed through the liver upward, from the under surface, and, when its eye emerges on the upper surface, the free end of the ligature there awaiting it is seized and drawn backward through the tract, to emerge upon the under surface of the liver. Again the empty needle is passed 1 cm. ($\frac{7}{16}$ inch) from the last puncture, passing from the upper to the under surface of the liver, where it seizes the free end in that position, and draws it upward through the liver, to the upper surface _ where it is again tied to the end there _ and so on, to the end of the interlocked ligature, at the free margin of the liver, to each side of the midpoint of beginning. Thus the entire area is backed by an interlocking, constricting ligature and the portion of liver substance within, including the tumor, is excised in the usual manner.

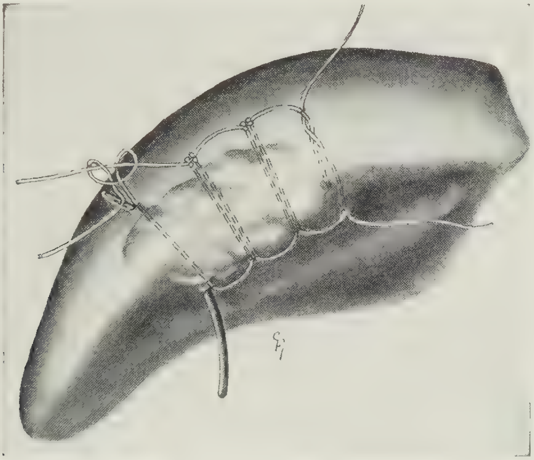


Fig. 3651.—Excision of Liver Tumors After the Application of Auvray's Interlocking Ligature; _ As detailed in the text.

Kousnetzoff and Pensky's Pocketing Method of Using Gauze Tampon Packs to Control Hemorrhage Following the Excision of Liver Tumors (Fig. 3652).—This method is frequently employed when preliminary control by a surrounding ligature cannot be carried out. The tumor is excised by the removal of a wedge-shaped piece, or in such a way as to leave two surfaces which can be approximated. Individual vessels are controlled by ligature as far as possible. Further bleeding is checked by suturing together the opposite margins of the capsule of the liver, upon both upper and lower surfaces, but not at the margin. Into the pocket thus formed gauze is packed (Fig. 3652) –

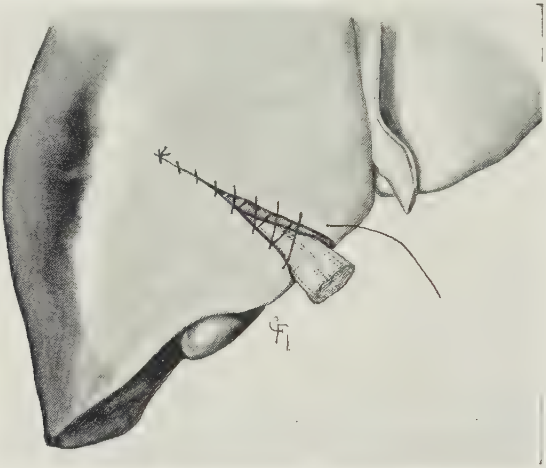


Fig. 3652.—Kousnetzoff and Pensky's Pocketing Method of Using Gauze Tampons to Control Hemorrhage from the Liver – following excision of tumors and in some wounds.

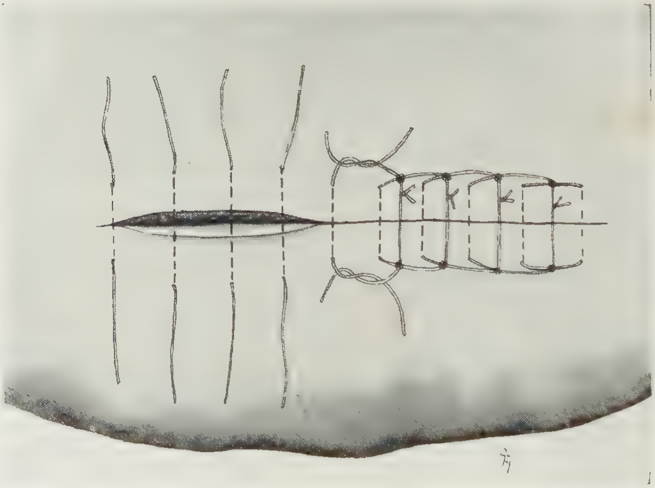
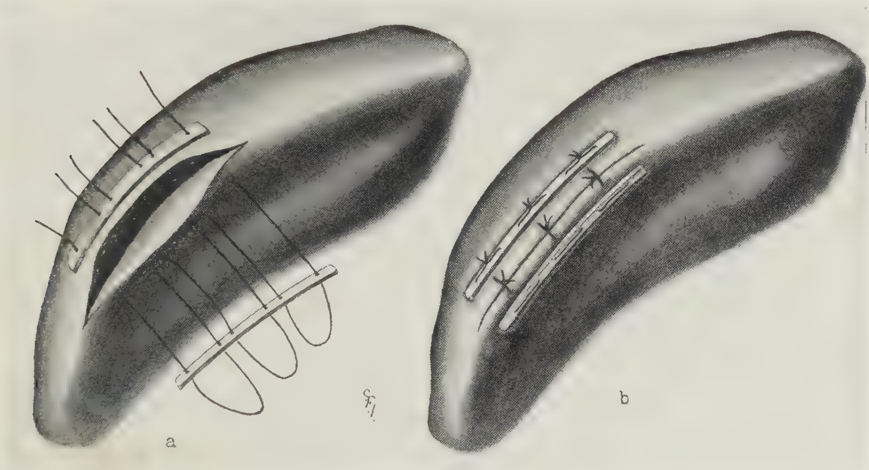


Fig. 3653.—Hough's Method of Hemorrhage Control Following the Excision of Liver Tumors – as explained in the text.

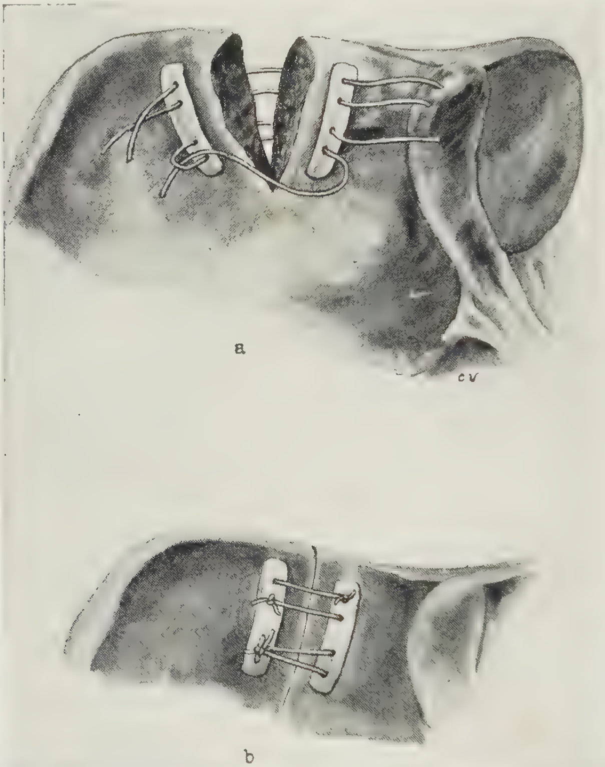
or sometimes the gauze is first packed, and the pocket formed by suturing the liver around it. The portion of gauze pack protruding from the liver pocket is conducted out through the abdominal wound, which is sutured up to its site of exit. The pack remains *in situ* from ten days to two weeks. Sometimes the wound aspect of the liver is anchored, by suturing, to the abdominal wall _ though this is usually unnecessary.

Hough's Method of Hemorrhage Control and Wound Suturing Following Excision of Liver Tumors (Fig. 3653).—Having completed the excision, the wound is crossed by a series of interrupted heavy catgut sutures which are placed either deeply enough to pass entirely underneath the bottom of the wound, or very nearly to the bottom, entering and leaving the liver substance about 1.2 cm. ($\frac{1}{2}$ inch) from the margins with long ends left for the special method tying (Fig. 3653). All of the sutures are placed before any are tied. Then, instead of tying the opposite ends of the same suture together, as one ordinarily does, the ends of the first two contiguous sutures are tied together on the same side of the wound _ after which the opposite ends of the same two sutures are tied together on the opposite side of the wound, with sufficient tautness to draw the opposing faces of the wound together by what amounts, practically, to a mattress-suture. Thus, two free ends are left on one side of the wound and, similarly, two free ends are left upon the opposite side. The ends are then tied together, thus approximating the surface of the wound between them _ as the corresponding depths of the wound have been drawn together by the mattress-suture. And the other free ends of the set are tied on each side _ thus making the second mattress-suture _ while the other two free ends of the two sutures are tied together across the wound. When all the deep mattress-sutures and all the superficial sutures approximating the margins of the wound are tied, the effect is as shown in the illustration.



Figs. 3654 and 3655.—Hemorrhage Control and Wound Closure by Means of Magnesium Plates in Excision of Liver Tumors: _ **a**, The wound left after excising a tumor by elliptic incisions paralleling the free border of the liver, with the plates in position and threaded; **b**, the sutures tied, approximating the wound surfaces.

Hemorrhage Control and Wound Closing by Means of Magnesium Plates Following Excision of Liver Tumors (Payr and Martina).—The approximation of liver surfaces, left after the excision of tumors, may often be greatly aided by the use of magnesium plates _ which are furnished of various sizes, shapes, and borings (Figs. 3654–3657). These plates of pure magnesium are cutable to suit conditions _ sterilizable _ absorbable _ and exercise a hemostatic influence. Their general method of application consists in the placing of a plate along each side of the liver wound, or surface, at a reasonable distance from the borders, so as to approximate the depths of the wound or surfaces. Mattress-sutures of stout catgut are passed through the holes, singly or in pairs _ and, when drawn taut, the free ends are tied. They may be used upon one or upon both sides of a wound, or at its end. If two plates are employed so that, together, they form an ellipse about the wound, then two free ends of the suture should project from the last two holes of the plate, on both sides, and at both ends of the plates, so that after drawing the plates together, by knotting first one side, and then the other, a single limb of each suture may be tied over the end _ thus uniting all four ends of the two plates (Fig. 3658). Some of the various ways in which these plates may be applied are shown in this and the preceding figures. The sutures are carried by a dull-pointed Reverdin needle.



Figs. 3656 and 3657.—Hemorrhage Control and Wound Closure by Means of Magnesium Plates in Excising Liver Tumors, of the Margins; or in Wounds: **a**, Different methods of placing the wires are shown; **b**, different ways of tying them. Also the plates may be placed upon both upper and lower aspects of the liver _ or only upon one aspect.

Frank's Method of Hemorrhage Control Following the Excision of Marginal Tumors of the Liver.—Where the thickness of the liver in the site from which the tumor is removed is not too great, two small wedges are excised from each aspect of the liver wound _ for the purpose of making possible the bringing together of the opposite surfaces of the liver, including,

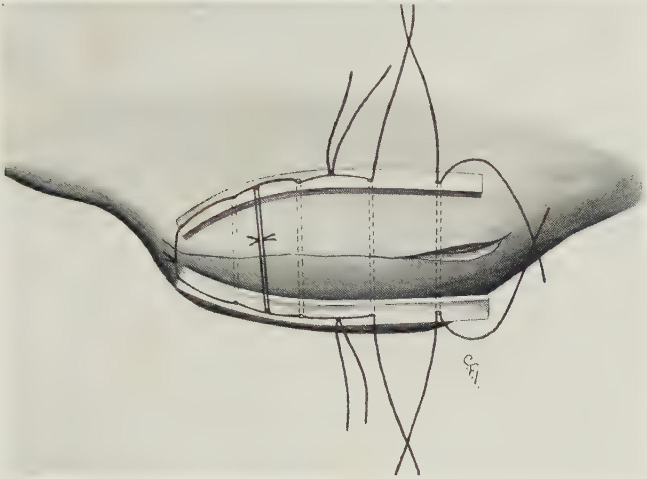
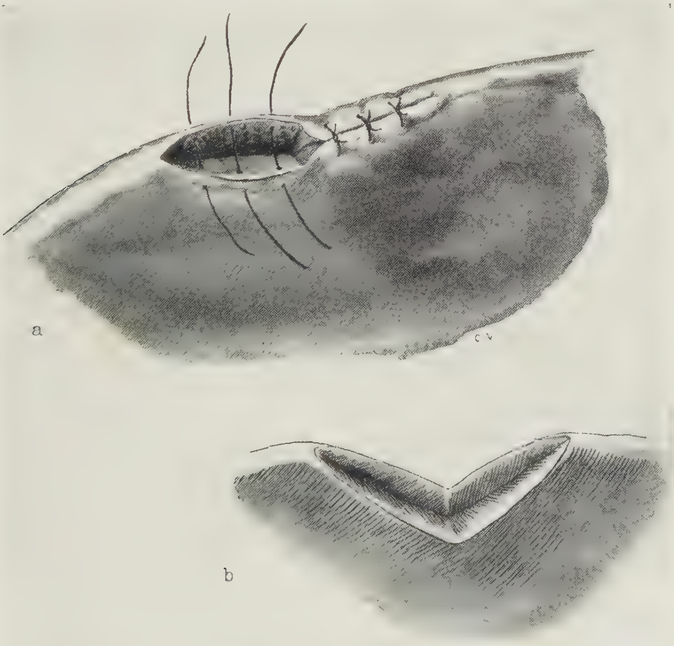


Fig. 3658.—Hemorrhage Control and Wound Closure by Means of Magnesium Plates in Excising Liver Tumors; – Where a prominent, projecting stump is left the ends of the magnesium plates may be connected by tying one thread of each one of the terminal sutures with its opposite, corresponding thread, over the ends of the plates. The double threads, midway between the deep penetrations, are tied superficially over the wound in a transverse direction. For further explanation see text.



Figs. 3659 and 3660.—Hemorrhage Control in Excising Liver Tumors by Excising a Wedge-shaped Piece of Liver Substance from Each Side of the Liver Wound Left, after Excising the Tumor – Followed by the Suturing of Glisson's Capsule of the Opposite Surfaces Together: – a, On one side the wedge-shaped excision from the side of the wound is shown, with sutures placed – and, on the other, the sutures are tied; b, appearance of the part after excision of both tumor and wedge prior to suturing.

if possible, Glisson's capsule, – this is shown on the patient's right (Figs. 3659, **a** and 3660, **b**). On the left the sutures are shown tied, bringing the upper and lower aspects of the margins into contact (Fig. 3659, **a**). The natural rounded border of the liver is broken by the V-shaped incut, whose margins are sutured.

Kocher's Clamp Method of Excising Liver Tumors.—Kocher suggests the use of large, powerful pressure-forceps for controlling hemorrhage, such as are used in stomach excisions. The technic, quoting from Kocher, was as follows, "In spite of the great thickness of the right lobe, which was in no way divided from the rest of the liver, but was greatly elongated, we put on a pair of large forceps behind the nodule (in a case of carcinoma of the right lobe and gall-bladder), closed them tightly, and so crushed the liver tissue. The forceps kept their place well, and stood the strain perfectly. The liver, together with the gall-bladder, was simply cut away with a knife close up to the forceps. The forceps were kept on for forty-eight hours, and were then removed without any hemorrhage. On the ground of this experience we can recommend the use of such forceps, and we advise that they be closed as tightly as possible, for though the liver tissue is friable the serous covering is very tough." Continuing, Kocher states that the use of forceps is associated with the disadvantage of not being able to bring the edges of the wound together, so that if vomiting takes place, prolapse of the intestine is apt to occur (as happened in two of his cases, ending fatally in one). The abdominal wound is closed up to the smallest space through which the clamp can be removed. He also suggests that the forceps may be replaced by mattress-sutures placed behind them (as in stomach surgery) – and, if need be, by continuous suturing carried over all. If a wedge-shaped gap be made by actual cautery, serous sutures may be sometimes applied. He considers it an important part of the technic to pack any exposed wound surface with xeroform gauze, for forty-eight hours, without exception – and to make provision for drainage of blood and bile.

Extra-abdominal Treatment of Liver Tumors by Means of Rubber Tourniquet Constriction Applied Behind Crossed Steel Rods.—This method, formerly used in the case of tumors of the uterus, has been applied to some cases of tumors of the liver, where it was possible to deliver the tumor through the abdominal opening – and where other measures seemed unsafe. Proximally to the tumor stout steel skewers are passed entirely through that aspect of the tumor from which the tumor springs, and at a safe distance from it – and proximally to the crossed skewers fairly stout rubber cord or tubing is wound one or more times, and tied. Thus the tumor, tourniquet, and skewers all lie upon the skin aspect of the abdominal wall. The abdominal wound, including the peritoneum, are sutured up snugly around the neck of the tumor – which is allowed to slough off, by which time the lumina of the vessels are usually obliterated. If the tension be not too great, and if it seem that the skewers will not tear through the pedicle, the tumor may be excised – thus leaving only its pedicle outside of the abdomen.

Comments.—Considerable control of hemorrhage may be exercised by an Assistant's grasping the liver substance between his fingers and compressing it proximally to the site of section.

Profuse bleeding from cut surfaces may often be controlled by gauze packing firmly and promptly applied – until the flow is checked – and then, as the gauze is slowly and carefully withdrawn, it is often possible to clamp and ligate the individual vessels.

Certainly in the majority of cases bleeding can be controlled by careful, systematic ligaturing and suturing.

When magnesium plates are used, considerable formation of gas occurs, as the magnesium is decomposed _ resulting in gas-cysts and adhesions. The gas is eventually absorbed. Bone-plates and cartilage-plates have also been used.

It has been suggested to employ Nagelschmidt's diathermic apparatus, for the purpose of sending an electric discharge into the liver substance beyond the cautery electrode, thereby producing heat coagulation and liver necrosis _ with consequent prevention of hemorrhage.

According to Thoele, the real mortality of a series of excised tumors of 148 cases collected, the real mortality was only 16.8 per cent. Keen quotes a mortality of 14 per cent. in another series. Most of the fatalities which have occurred in tumor excisions have come from hemorrhage and shock.

It has been shown that the divided ends of the large veins of the liver can be isolated and ligated. The bleeding is often first controlled by finger-tip pressure _ then the vessels seized with a hemostat, sufficiently freed to hold a ligature, and tied.

Cauterization, slowly made, at dull red heat, is very effective in controlling ill-defined bleeding. Gauze packing is also effective in this class of bleeding, especially if aided by the formation of pockets, as described (pp. 457–458).

Injection of 1 : 1000, to 1 : 10,000 adrenalin in saline solution largely controls oozing _ and makes easier the ligation of larger vessels which are divided.

Kocher suggests combining mass ligatures, applied one after another, as one progresses _ and in conjunction with the ligation of larger vessels encountered in the field. He considers that the magnesium plate ligatures act as mass ligatures.

If magnesium plates are applied too tightly, liver necrosis is apt to occur, often followed by embolic pneumonia.

A particular advantage of wedge-shaped excisions is not only to enable the liver surfaces to be brought together, but also the peritoneum surfaces of Glisson's capsule. If the peritoneum cannot be approximated, Kocher advises the placing of a strip of xeroform gauze, wrung out in carbolic acid, placed on the line of sutures, and drainage-tubes carried through the abdominal wall down to it, along with the exit of the gauze. (One might be inclined to substitute simple gauze.)

He counsels the suturing of Glisson's capsule with silk _ while ligaturing be done with catgut.

TREATMENT OF WOUNDS OF THE HEPATIC ARTERY AND PORTAL VEIN IN OPERATING ABOUT THE LIVER AND GALL-BLADDER

In the many operations which are now being performed upon the liver, gall-bladder, biliary ducts, and upon the pylorus and duodenum, in the immediate vicinity of the hilum of the liver, injury to the hepatic artery and to the portal vein has been committed _ and it is well to have a definite idea as to the best way of meeting such possibilities.

In the first place, ample exposure is especially demanded _ and if the original exposure, for the planned operation, be insufficient, this incision must be promptly and unhesitatingly added to, while the hemorrhage is temporarily checked by pressure, or gauze packing. The Trendelenburg position may aid in accomplishing the desired end.

In dealing with wounds of these large and important vessels, it is to be remembered that death is by no means inevitable _ and that life has been saved, under such circumstances, by firm gauze packing alone. It behooves one, therefore, to maintain control of the situation psychologically in spite of the difficulties and discouragements which may be encountered.

As to the hepatic artery, it is known that it is possible to ligate its trunk, because of the resulting collateral circulation between the gastroduodenal and right gastro-epiploic arteries. But necrosis of the liver is to be expected if ligation of the hepatic artery be made either proximal to the level at which these vessels are given off, or if the ligation be made after the arteries of the stomach have been tied.

Kehr has successfully tied the hepatic artery proximally (without subsequent necrosis) in a case where there was an aneurysm of a branch of the hepatic artery — collateral circulation having formed between the phrenic arteries (by way of the coronary ligament and Glisson's capsule) — the collateral anastomosis having paved the way to the successful ligation.

In the necessary manipulations, additional room is secured by displacing the liver well upward (unless the patient be in the Trendelenburg position) — putting the duodenum and gall-bladder under tension — and bringing the hepatoduodenal ligament into the field, with the hepatic artery, portal vein and biliary duct, or the hepatic duct, lying within reach.

In dealing with the portal vein, it is sought to repair the wound by axial suturing of the rent (the blood-pressure being low in this vessel) — or by grasping the opening in the vein with forceps and drawing it forward, while a purse-string ligature is tied around its neck.

If failure follow all efforts, the best recourse is to firm systematic packing of the site with strip gauze, so as to secure the effect of pressure from a graduated compress.

CHAPTER LXX

OPERATIONS UPON THE GALL-BLADDER AND BILIARY DUCTS

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SURGICAL ANATOMY OF THE GALL-BLADDER

Description and Position.—Bound to the fossa of the gall-bladder, upon the under surface of the liver, by connective tissue and vessels, lying between the right and quadrate lobes _ its fundus reaching the abdominal wall, anteriorly _ and its neck extending to the transverse fissure, posteriorly. Its fundus and inferior and lateral aspects are covered with peritoneum reflected from the liver. It sometimes has a mesentery. Its neck points backward and upward, toward the transverse fissure of liver, _ its fundus points downward and forward toward the anterior border of liver. Its length is from 7 to 10 cm. ($2\frac{3}{4}$–4 inches) _ the width of its fundus is from 2.5 to 3 cm. (1–$1\frac{3}{16}$ inches) _ and it holds about 20 c.c.

Relations.—**Superiorly;** _ fossa of gall-bladder; _ **Inferiorly;** _ duodenum (first and second parts); pyloric end of stomach (sometimes); colon (hepatic flexion and commencement of transverse portion); _ **Anteriorly;** _ abdominal wall; ninth costal cartilage.

Arteries.—Cystic, from right branch of hepatic.

Veins.—Cystic (two) emptying into right branch of vena portæ; others emptying into liver.

Lymphatics.—Run into a gland at its neck.

Nerves.—Supplied by celiac plexus.

Fixations.—Connective tissue; vessels; peritoneum reflected over under surface of liver; cystoduodenal ligament (a fold of peritoneum extending from the neck of the gall-bladder to the duodenum).

SURGICAL ANATOMY OF THE GALL-DUCTS

Hepatic Duct.—Formed by right and left bile-ducts uniting generally at their emergence from the liver. Length from 3 to 5 cm. ($1\frac{1}{4}$–2 inches). Diameter, about 4 mm. (nearly $\frac{3}{16}$ inch). Passes downward in the right border of the gastrohepatic omentum, having the vena cava behind and the hepatic artery to the left. Unites with the cystic duct to form the common bile-duct.

Cystic Duct.—Begins at the neck of the gall-bladder _ is directed slightly to the left _ and ends at its junction with the hepatic duct at an acute angle, to form the common bile-duct. Length, 2.5 to 4 cm. (1–$1\frac{1}{2}$ inches). Passes downward, backward, and to the left in the gastrohepatic omentum – having the hepatic artery to left and portal vein behind.

Common Bile-duct.—Formed by the union of the hepatic and cystic ducts. Length, about 7.5 cm. (3 inches), dependent upon the site of union of the cystic and hepatic ducts. Diameter, about 6 mm. (nearly $\frac{1}{4}$ inch). Its course and relations are the following: – continuing the direction of the hepatic duct, it passes downward and backward in the hepatoduodenal portion of the gastrohepatic ligament, having the hepatic artery and its gastroduodenal branch to the left, and the portal vein behind and between – enters the right pancreaticogastric fold behind the first portion of the duodenum (superior curve), then passes between the second portion of the duodenum (descending part) and head of the pancreas – and ends by entering the posterior and inner wall of the descending portion of the duodenum (being crossed on the way by the pancreaticoduodenal artery), running obliquely for about 2 cm. ($\frac{3}{4}$ inch) through its walls and opening upon a papilla of mucous membrane about 10 cm. (4 inches) from the pylorus. The pancreatic duct joins the common bile-duct just before its termination.

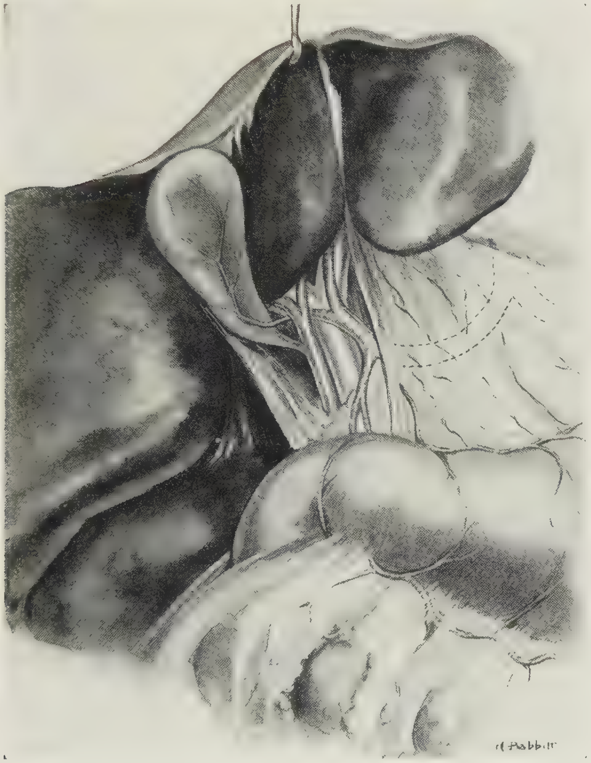


Fig. 3661.—Anatomy of the Gall-bladder and Ducts – Especially in Connection with the Structures In and Behind the Hepatoduodenal Ligament (the Right, Outer Aspect of the Gastrocolic Omentum); – The liver and gall-bladder are displaced upward – and the gastroduodenal junction downward In passing the left forefinger, with its pulp forward and nail backward, through the foramen of Winslow, one encounters, in going from the patient's right to left, the ductus choledochus (in the free border of the hepatoduodenal ligament), the portal vein, and hepatic artery – the vein lying between and somewhat posterior to the duct and artery. The anterior layer of the hepatoduodenal ligament has been removed.

SURFACE FORM AND LANDMARKS

The fundus of the gall-bladder projects outward beyond the anterior border of the liver, in the incisura vesicalis – generally resting upon the transverse colon – and coming into contact with the anterior abdominal wall close to the outer border of the right rectus muscle. Authorities differ as to the exact point of contact with the abdominal wall in relation with the costochondral structures; – according to Morris, the fundus lies opposite the cartilage of the right ninth or tenth rib; – according to Gray, opposite the inferior border of the right ninth costal cartilage; – and according to Treves, below the inner end of the right tenth costal cartilage.

GENERAL SURGICAL CONSIDERATIONS

The gall-bladder is in relation with the first and second portions of the duodenum, with the hepatic flexure and commencement of the transverse colon, and sometimes with the pylorus. Therefore the gall-bladder could generally be united with either duodenum or colon – but if united to the colon, the function of the bile in the small intestines would be lost – hence the duodenum is the usual site of anastomosis.

In examining the gall-bladder and ducts, first pass the left index over these structures, to gain an idea of their size and contents – then let the left index slip through the foramen of Winslow (Fig 3662) – in which position the left thumb will grasp the ligamentum hepatoduodenale (the right margin of the gastrohepatic omentum) and press it against the left index – and thus the ducts can be palpated between thumb and index, upward and downward.

By drawing upon the gall-bladder the gall-ducts are rendered more tense and evident.

The pedicle of the gall-bladder consists of cystic duct, artery, and veins.

The common bile-duct lies in the hepatoduodenale ligament, near its right free margin – in the free border which constitutes the fold at the entrance of the foramen of Winslow – the hepatic artery lying nearby to its left – and the vena porta behind and between the common duct and hepatic artery – owing to which important relations the ducts should be fully exposed before being opened. (See Figs. 3661–3663).

Where more than usual room is required, resection of the right costal arch may be performed.

No suture should be used which will come within the lumen of any of the ducts – for fear of forming the nucleus of calculi.

The exact nature of the operation to be done is frequently not known until the gall-bladder and ducts are exposed and examined.

In a condition of moderate distention the gall-bladder may hold from 50 to 60 cc., – and, in marked distention, several times this much (between 200 and 250 c.c.).

The fundus of the gall-bladder, especially if distended, extends beyond the anterior border of the liver, in contact with the abdominal parietes, generally opposite the ninth or tenth costal cartilage, where the outer border of the right rectus crosses the costal arch. It lies sometimes well to the right of this.

While the inferior aspect of the gall-bladder usually lies in touch with the second portion of the duodenum and with the transverse colon, if displaced upward, it may be in touch with the first portion of the duodenum, with the pyloric end of the stomach, or even with the anterior aspect of the stomach, and if displaced downward, it may touch the ascending colon, or the anterior aspect of the right kidney.

Peritoneum covers all of the gall-bladder which is not directly connected to the cystic fossa. (Rarely, a mesentery connects the gall-bladder to the cystic fossa.)

A moderately distended gall-bladder can often be felt by palpation – if the abdominal wall be of average thickness.

The gall-bladder is the reservoir for the bile, and is supposed to fill up during the intervals between eating, especially at night, and to empty its contents during digestion.

The gall-bladder is sometimes absent – and its loss by excision is not known to cause inconvenience.

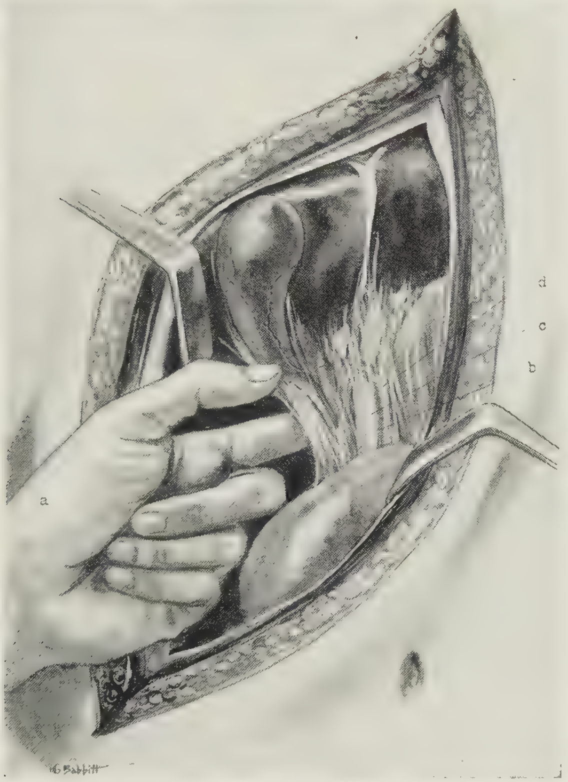


Fig. 3662.—Palpation of the Structures in the Hepatoduodenal Ligament, after Passing the Left Index-finger Through the Foramen of Winslow: – **a,** Hepatoduodenal ligament (the right aspect of the gastrohepatic omentum), which is being palpated between index and thumb; – **b,** common duct; – **c,** vena portæ; – **d,** hepatic artery.

The point at which the fundus of the gall-bladder most frequently comes into contact with the anterior abdominal wall may be taken to be the intersection of the right semilunar line and the costal arch – which is usually marked by a slight depression at the anterior end of the ninth right costal cartilage.

A succession of crescentic, valvular infoldings of the mucosa marks the entire cystic duct – especially marked at its upper end, next the gall-bladder.

The cystic artery courses along the inner side of the cystic duct.

The hepatic duct lies, throughout its course, between the anterior and posterior layers of the gastrohepatic omentum _ passing, at its beginning, anteriorly and perpendicularly over the right branches of the hepatic artery and portal vein _ while, below, it lies antero-external to the portal vein.

The common bile-duct descends between the two layers of the gastrohepatic omentum, coursing along the right border of the lesser omentum, lying to the right of the hepatic artery, in front of the portal vein, and passes behind the first portion of the duodenum. It then either passes between the head of the pancreas and the second portion of the duodenum (exceptionally), or through the head of the pancreas (usually). (But even when it passes through the pancreas, it generally joins the pancreatic duct outside of the pancreas.) It passes down to the right side of the pancreatic duct and runs, with it, through the wall of the descending part of the duodenum, in the submucous tissue between the muscularis and mucosa, for a distance of from 7 to 14 mm. ($\frac{1}{2}$–$\frac{3}{4}$ inch).

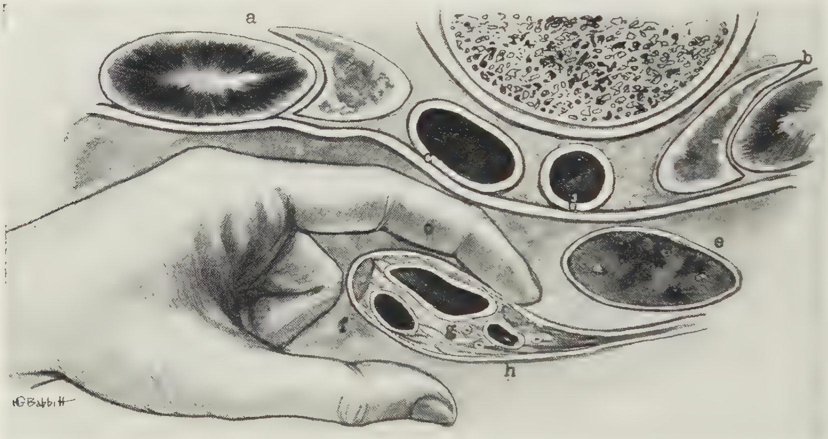


Fig. 3662A.—Palpating the Structures in the Hepatoduodenal Ligament _ the Outer Aspect of the Gastrohepatic Omentum _ Between the First Finger of the Left Hand, in the Foramen of Winslow, and the Thumb Upon the Outer Aspect of the Ligament: _ **a,** Right kidney and capsule; _ **b,** left kidney and capsule; _ **c,** inferior vena cava; _ **d,** abdominal aorta; _ **e,** lobus Spigelii; _ **f,** ductus choledochus; _ **g,** portal vein; _ **h,** hepatic artery; _ **o,** finger within the foramen of Winslow palpating the posterior aspect of the hepatoduodenal ligament.

The common bile-duct, as well as the cystic and hepatic ducts, is very distensible _ as shown in cases of calculi _ stretching sometimes to the site of the small or large intestine.

The common bile-duct and the pancreatic duct generally unite just before they empty into the duodenum _ but sometimes empty into it independently (in about 10 per cent. of the cases).

The common bile-duct is divisible into the following parts _ of practical importance because of the frequency and importance of operations upon the structure: _ (*a*) Supraduodenal portion _ courses down in the free margin of the gastrohepatic omentum, anterior to the foramen of Winslow, lying antero-external to the portal vein, and having the hepatic artery to its median side; _ (*b*) Retroduodenal portion _ lies posterior to the first part of the duodenum, closely in contact with the duodenum, with the portal vein lying internally and the vena cava posteriorly; _ (*c*) Pancreatic portion _ extends from the lower border of the first part of the duodenum to the site, in the second part of the duodenum, where the duct penetrates the intestine _ with the inner wall of the duodenum to its outer aspect, the superior mesenteric vein to its inner aspect, the inferior vena cava posteriorly _ and the duct either in contact with the pancreas or surrounded by pancreatic tissue; _ (*d*) Intraparietal portion _ within the wall of the duodenum, coursing obliquely downward and inward.

In exposing the hepatoduodenal ligament, for palpating the important structures contained therein, access to the foramen of Winslow is made easier by first elevating the anterior border of the liver, as though rotating it upon its transverse axis. Another way of locating the common duct is to first expose the cystic duct _ and then trace this downward to its junction with the hepatic duct to form the common duct. The recognition of the common duct is sometimes quite difficult when adhesions are present.

The special bearing of some other general surgical considerations will be given under the particular operatons upon the individual structures of the gall-bladder tract.

Many of the illustrations and some of the text of the present chapter are modifications of the epochal work of Kehr.

OPERATIONS FOR THE EXPOSURE OF THE GALL-BLADDER TRACT, IN GENERAL

In operating upon the gall-bladder and the biliary tract _ irrespective of the object of the special operation _ it is of first importance to plan for as free and satisfactory exposure of the parts as possible. While, naturally, this is true of exposing all fields of operation, it is especially true here _ because of the depth at which the structures lie, the unusual importance of their surroundings, and the difficulties and complications which are apt to be encountered.

Some of the more generally employed methods of approach will be described and illustrated in the immediately following pages _ before taking up the special classes of operations.

In addition to these it will, of course, be apparent that several of the operations already described for exposing the anterior aspect of the lower border of the liver (pp. 441–444) will, at the same time, serve to expose the gall-bladder and biliary ducts. Of the operations already described under the liver, for the exposure of that viscus, those which may be especially used in also exposing the biliary tract are the following: _ Exposure of the anterior aspect of the liver, and of the gall-bladder, by anterior oblique incision, parallel with the right costal arch; _ Exposure of the anterior aspect of the liver, and of the gall-bladder, by vertical incision, just to the right of the median line, with right angular or hooked extension (Perthes); _ Transperitoneal exposure of the dome of the anterior aspect of the right lobe of the liver by chondroplastic or costochondroplastic flap; _ Subcostal exposure of the anterior aspect of the liver by vertical incision through the outer part of the right rectus muscle.

Preference, however, would be given to the methods immediately following _ which deal more particularly with the gall-bladder and biliary tract rather than with the liver at large.

Anesthesia _ Analgesia.—Anesthesia is indicated in operations upon the gall-bladder tract _ and fairly deep anesthesia _ ("very deep," Kehr states). One never knows in advance just what is to be encountered in operating upon the biliary tract _ and while the mere opening, anchorage, and drainage of an infected gall-bladder is often a simple procedure, especially in thin-walled patients, and might be performed, comfortably to the patient and easily for the Surgeon, under analgesia, the procedure is not to be advised.

Position of the Patient.—The operative manipulations upon the biliary tract may be made harder, especially in the stout, by whatever position tends to cause the liver to recede beneath or to be pushed under the ribs _ and, on the other hand, be made very much easier, and the structures of the entire biliary tract be very much more prominently brought forward by combining two features _ the position of the patient upon an inclined plane, with the pelvis lower than the thorax _ and the placing of a firm support under the patient's back at the junction of the dorsal and lumbar vertebræ (v. Fig. 3603). The support for the back must not be too broad or it will defeat part of its object. The lowered position of the pelvis also tends to direct the movable abdominal contents away from the gall-bladder region _ and also to lengthen out the bile-ducts and the hepatoduodenal ligament in which they run.

One of the best positions for gall-bladder and gall-duct work is that given by Elliott, of Boston, in his own words: _ "The patient is hung by straps under the arms on an inclined plane at an angle of something less than 45 degrees. A sand-bag is placed under the back, so that the patient is bent over it. In this position the intestines gravitate to the lower part of the abdomen, so that when the liver is held up by a retractor, the air sucks in between the liver and the intestines, much as it enters the pelvis in the Trendelenburg position." The only objection to this position (which does not outweigh its advantages) is that when a simple vertical incision is used the lips of the wound tend to be approximated and tensed by the posture of the body _ which, however, is avoided in other types of incision.

Chief Indications for Operations Upon the Gall-bladder.—The conditions for which surgical relief is most frequently sought are _ infective cholecystitis and gall-stones _ or both combined.

Chief Operations Performed Upon the Gall-bladder.—The procedures most frequently employed in gall-bladder disease (apart from the involvement of the ducts) are _ cholecystotomy, cholecystostomy, cholecystenterostomy, and cholecystectomy _ the nature of which operations, and the indications for each, will be given under the individual operations.

EXPOSURE OF THE GALL-BLADDER AND BILIARY TRACT BY KEHR'S WAVE OR BAYONET INCISION

The incision begins close to the tip of the ensiform cartilage, and passes vertically downward in the middle line for about 4 to 6 cm. ($1\frac{9}{16}$–$2\frac{6}{16}$ inches) toward the umbilicus. It is then directed obliquely outward, parallel with the right costal arch, until the outer third of the right rectus muscle is reached _ after which it is continued directly downward, in the outer third of the rectus, until it comes nearly or quite to the level of the umbilicus.

Its relation to the intercosto-abdominal nerves is seen in Fig. 3663. It will be seen that it avoids the upper nerves in its course _ and the terminal portions of the one or two with which it is apt to come into contact are carefully exposed and retracted, as shown in the illustration of the operation by the bow-shaped incision.

The incision through skin and fascia exposes the properitoneal fat in the upper part of the median line _ and, crossing the second linea transversa obliquely to the outer third of the muscle, whence it passes downward, divides the inner two-thirds of the external sheath of the right rectus _ and then splits the outer third of the muscle in the cleavage line of its fibers.

As the remaining details of the operation are practically the same, in both the exposure by Kehr's wave incision and in his bowed incision (Bogenschnitt), they will be described under the latter which follows.

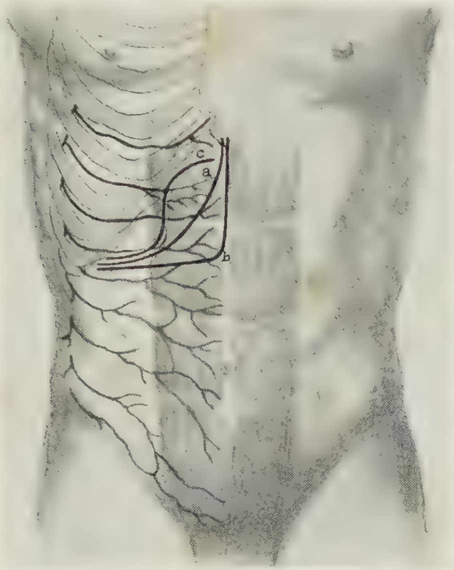


Fig. 3663.—Some Incisions for Exposing the Gall-bladder and Bile-ducts _ Shown in Relationship with the Nerve Supply of the Parts: _ **a,** Kehr's bow-shaped incision; _ **b,** Czerny-Kocher angular incision; _ **c,** Kehr's wave incision.

EXPOSURE OF THE GALL-BLADDER AND BILIARY TRACT BY KEHR'S BOW-SHAPED INCISION

The position of the incision is shown at **a,** Fig. 3663. It will be seen how it tends to avoid the intercosto-abdominal nerves, by first passing down the median line, and then outward, often, or in large part, parallel with the nerves. When nerves are encountered in the course of the incision, they are safeguarded as far as possible _ as explained below.

The incision begins in the median line at the ensiform cartilage. It passes directly downward in the linea alba for from 4 to 6 cm. ($1\frac{9}{16}$–$2\frac{6}{16}$ inches) _ and then rounds obliquely downward and outward, toward the right costal arch.

If the upper part of the incision be strictly in the median line, the subserous areolar tissue is opened up at once and generally protrudes forward. In proportion, as it deviates slightly from the median line, the rectal sheath of one side or the other may be incised, and the inner border of one of the rectus muscles be brought into the field. The obliquely bowed portion of the incision at first passes through the outer sheath of the rectus only _ as shown in Fig. 3664. The right rectus muscle is then carefully divided in the same obliquely curved line being sure to at first divide nothing below the muscle, and to harm no nerve _ and the divided muscular branches are seized and tied with catgut. The divided ends of the muscle retract considerably, especially while the back is supported by a cushion (which should be withdrawn prior to the repair of the wound.) The transverse fibers of the transversalis are usually visible in the outer part of the cut. One should be carefully on the lookout for the intercosto-abdominal nerves of the region _ which come forward between the internal oblique and transversalis, and penetrate the rectal sheath, to supply the muscle. Any nerve encountered is carefully drawn to one side, or the knife or scissors slipped underneath it _ as seen in Fig. 3665 (where the tenth intercostal nerve and accompanying vessels are shown)

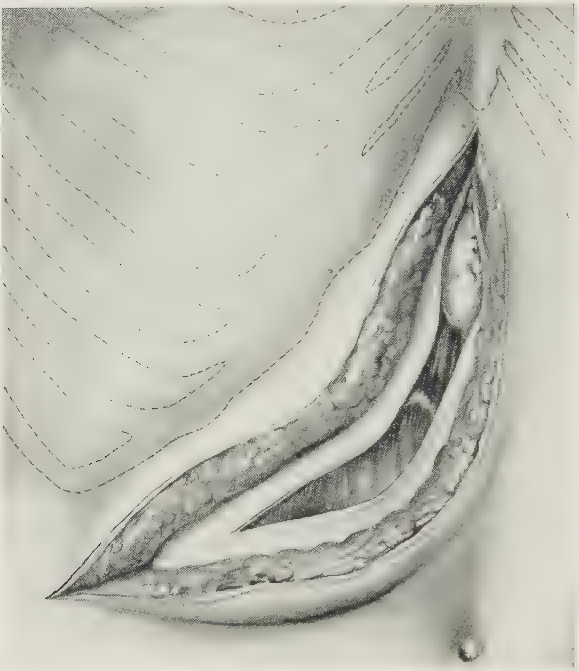


Fig. 3664.—Exposure of Gall-bladder and Biliary Tract by Kehr's Bow-shaped Incision — I; — Incision through superficial parts — properitoneal fat being shown in the upper part of wound in the median line (where the inner margin of the opposite rectus muscle is also shown) — and the outer layer of the rectal sheath is seen incised in lower part of the wound. (Figs. 3664 and 3665, modified from Kehr.)

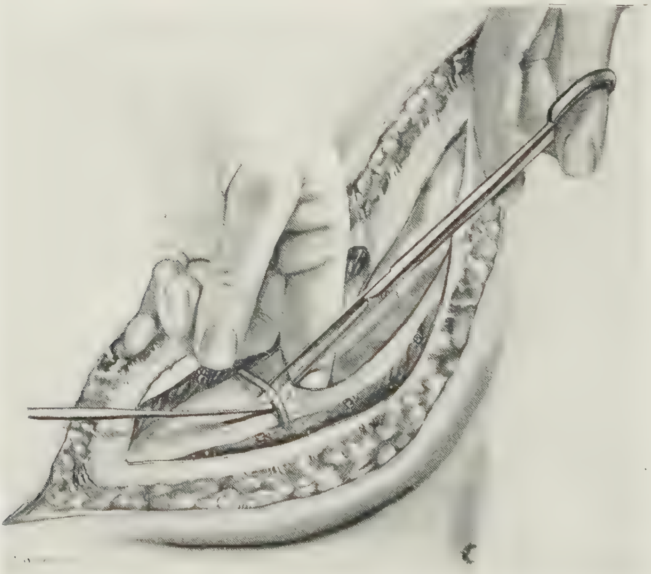


Fig. 3665.—Same — II; — Deeper aspect of wound — showing rectus obliquely divided (divided muscular vessels being ligated) — and tenth intercosto-abdominal nerve, between muscle and posterior rectal sheath. Division of posterior rectal sheath is shown in upper part of wound — and safeguarding of intercosto-abdominal nerve in lower part.

– while incising the posterior layer of the rectal sheath. The structures are picked up and drawn into a ridge by two forceps, held by Surgeon and Assistant, and, at first, cautiously nicked with knife or scissors, as the peritoneal cavity is entered – cutting through the posterior layer of the rectal sheath, the properitoneal fat, and the perioneum – after which the opening may be enlarged with scissors.

Having exposed the cavity, the anterior margin of the liver, and often the fundus of the gall-bladder are brought into the field. To enable freer manipulation and exposure, the round ligament may be doubly clamped and divided, while the structure is supported by the first two fingers of the Surgeon's left hand (Fig. 3666) – after which both ends of the divided ligament are tied with catgut.

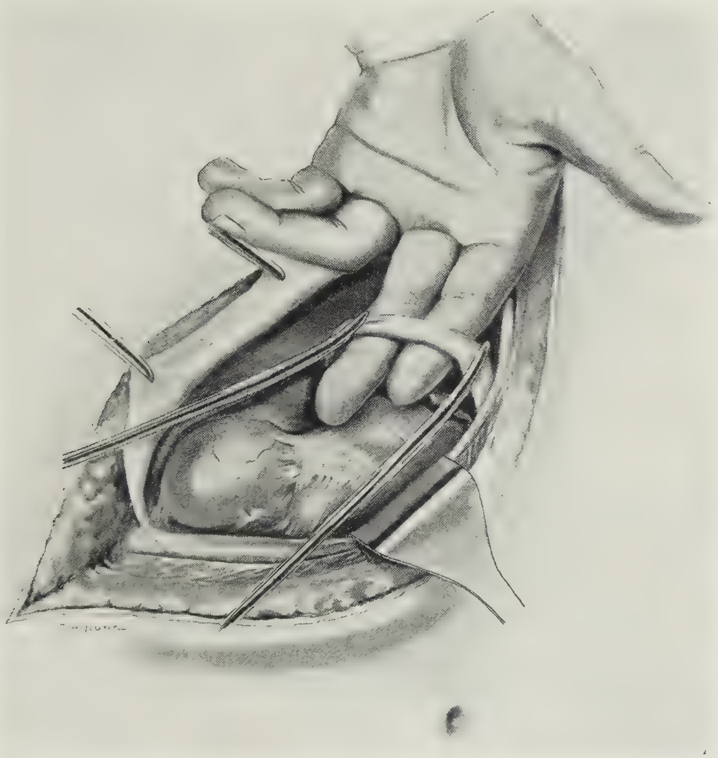


Fig. 3666.—The Same – III; – The abdomen has been opened and the borders of the wound retracted, showing the anterior border of the liver and the distended gall-bladder. The round ligament of the liver has been doubly clamped, prior to dividing it and tying the cut ends – as is sometimes done in order to secure freer access to the involved structures.

The structures of the gall-bladder tract are now ordinarily accessible to sufficiently free exposure for the accomplishment of the object of the operation.

Upon the completion of the special procedure the divided rectus is carefully sutured, while the patient's body is in such position as to enable the cut ends of the muscle to be approximated.

EXPOSURE OF THE GALL-BLADDER AND BILIARY TRACT BY MAYO'S STRAIGHT, OBLIQUE, PARAMEDIAN INCISION

Formerly the gall-bladder tract was exposed by a vertical incision passing directly downward from the fundus of the gall-bladder, which is a movable position – whereas, the fixed point is the junction of the gall-bladder and the cystic duct. The features of the present operation, are – that the superficial incision is a straight, oblique, paramedian one, to the right of the median line – while the deep incision is a vertical one, separating the fibers of the rectus muscle in their cleavage line – and the peritoneum in the same line. Such a combination of incisions gives a very satisfactory access to the gall-bladder, cystic duct, and common duct – the opening being planned to lie over the duct.

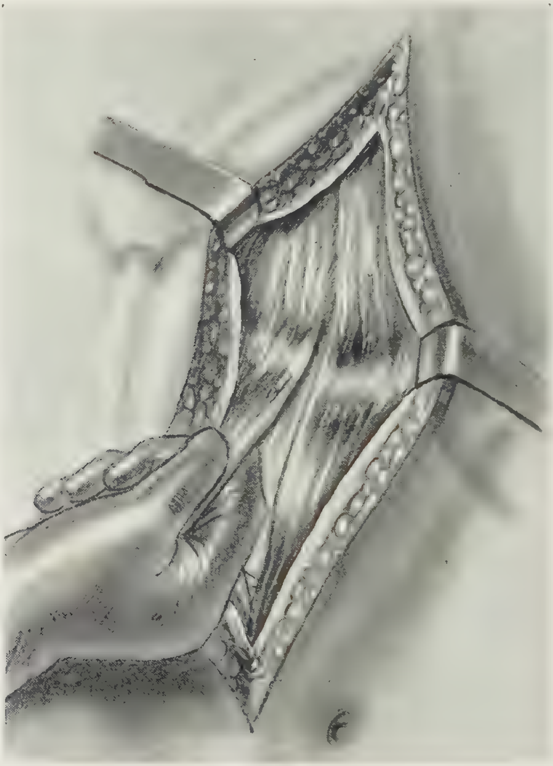


Fig 3667.—Exposure of the Gall-bladder and Biliary Tract by Mayo's Straight, Oblique, Paramedian Incision; – The details of the superficial and deep incisions are given in the text. A finger is separating the fibers of the right rectus muscle by blunt dissection in the line of cleavage. Branches of intercostal nerves encountered are displaced as far as this is possible.

The superficial incision begins to the right of and close to the xiphoid cartilage – "This will be near the midline, beginning directly beneath the ribs, to the right of the ensiform," as stated by Judd – and passes downward in a straight but slightly oblique line, to a point about 5 cm. (2 inches) to the right of and immediately on a line with the umbilicus. This cut divides the skin, superficial and deep fascia, exposing the rectal sheath.

The deep incision is made through the outer rectal sheath – a straight, vertical cut, parallel with the median line. This will cross the course of the superficial incision at very acute angles _ and splits the fibers of the rectus approximately midway between the umbilicus and the 2-inch point to the right of the umbilicus.

The fibers of the rectus are separated by blunt dissection (Fig. 3667) _ after which the posterior rectal sheath, properitoneal fat, and peritoneum are incised _ and the peritoneal cavity entered. If the requisite exposure be not secured, on entering the abdominal cavity, it is often helpful to divide the anterior aspect of the suspensory ligament of the liver (the anteroposterior peritoneal fold which is attached to the inferior aspect of the diaphragm, and to the posterior aspect of the sheath of the right rectus muscle, up to within 2.5 cm. (1 inch) of the navel _ and, below, to the convex surface of the liver, from its anterior notch, to its posterior surface). The ligament is divided between forceps _ after which the hepatic portion, still clamped, may be used as a tractor to aid in the exposure of the under surface of the liver without traumatizing the soft liver substance by efforts of direct retraction. At the end of the operation the cut surfaces of the suspensory ligament are sutured _ although the amount of its suspensory function is in doubt.

At the end of the special operation for which the exposure has been made the divided sheath of the rectus is repaired by suture, as well as the separated fibers of the rectus muscle _ the details of the closure being often modified by drainage.

EXPOSURE OF THE GALL-BLADDER AND BILIARY DUCTS BY THE CZERNY-KOCHER ANGULAR INCISION

The "Winkelschnitt," or angular incision, about to be described, was first employed by Czerny _ and was subsequently adopted by Kocher as his "normal incision" exposure of the gall-bladder tract in difficult cases _ using the oblique subcostal incision for simpler cases.

The incision begins in the middle line, at the ensiform cartilage, and travels directly downward for two-thirds the distance to the umbilicus _ at which point it turns outward and slightly upward toward the costal arch at an angle.

While the vertical portion of the incision lies in the median line, it aims to pass through fascia and outer rectal sheath in such a position as to open the inner border of the right rectus muscle.

The transverse portion of the incision divides as much of the width of the right rectus, including its anterior and posterior sheath, as may be necessary to accomplish the requisite exposure.

The special favorable features of this incision are, the room which it secures for manipulation _ and, especially, its total avoidance of intercosto-abdominal nerve-trunks, as the transverse portion of the incision passes outward between two adjacent nerves.

Owing to the transverse division of most or all of the muscle, the severed ends of the rectus are rather difficult to accurately and firmly suture at the end of the operation. No support should be under the patient's back at the time of this suturing. And if the suturing feature of the Perthes' method of exposure (p. 499) be adopted, the process should be simplified.

The manipulations within the abdomen, in the exposure of the individual structures of the biliary tract, are the same as in other methods of approach.

EXPOSURE OF THE GALL-BLADDER AND BILIARY DUCTS BY PERTHES' RECTANGULAR INCISION

This incision begins just under the xiphoid cartilage _ passes vertically downward as a paramedian incision, at a distance of about 2 cm. ($\frac{3}{4}$ inch) from the median line _ to a point directly to the outer aspect of the umbilicus

_ whence it passes outward and slightly upward toward the margin of the costal arch.

Open the anterior layer of the rectal sheath along the line of the vertical portion of the incision. Mobilize the inner border of the right rectus _ and carry the finger between the posterior surface of the muscle and the posterior layer of the sheath, on a level with the horizontal part of the incision (Fig. 3668). Pass two rows of interrupted sutures, ½ inch apart, along this horizontal part of the cut, connecting the anterior sheath of the rectus muscle with the rectus muscle itself. Then divide the rectus muscle between these two rows of sutures _ the stitching preventing the retraction of the muscle within its sheath. Reflect upward and outward the angular flap _ consisting of superficial structures, anterior rectal sheath, and underlying rectus _ and turn it over the costal margin _ exposing, in the act, the intercostal nerves as they enter the deeper aspect of the muscle (Fig. 3669).

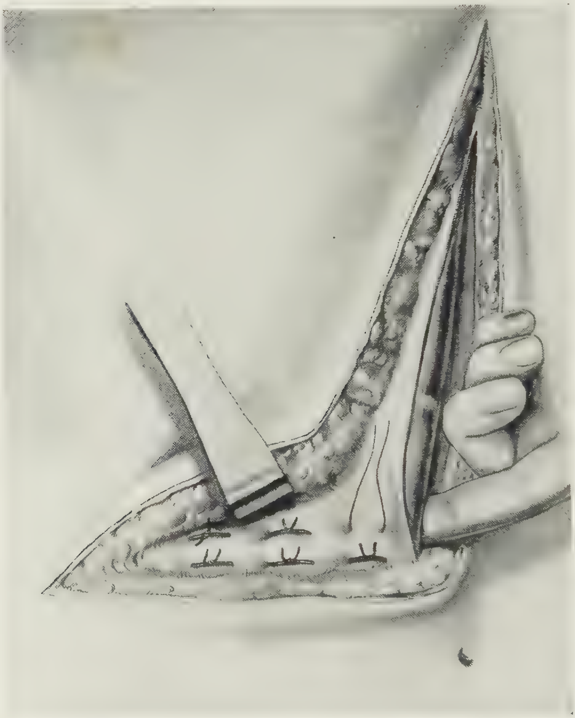


Fig. 3668.—Exposure of the Anterior Aspect of the Liver and of the Gall-bladder _ By vertical incision, just to the right of the median line, with right angular, or hooked extension _ Perthes' Technic _ I; _ The vertical portion of the incision has been made, through the anterior rectal sheath, and the posterior aspect of the rectus separated _ while with a finger between the rectus and its posterior sheath, two transverse tiers of sutures are being placed, anchoring the rectus to its anterior sheath _ prior to dividing it between these two tiers.

Now open the abdomen by incising the posterior layer of the rectal sheath and the peritoneum along an oblique line paralleling the right costal arch, from the upper to the lower limits of the wound _ as shown in the preceding picture. If more room be necessary, prolong the horizontal portion of the incision outward _ dividing the muscles in their cleavage line as far as possible.

The special features of this method of approach are the following: _ The nerves are preserved, avoiding paralysis; _ Owing to the manner of dividing the posterior layer of the rectal sheath, the stomach and intestines are more readily retracted from the field of operation than usual; _ Hernia is rendered unlikely, as the superficial and deep incisions do not lie over each other.

If drainage be necessary, it is brought out through the outer angle of the wound.

In closure, the cut margins of the rectus are approximated by deep catgut sutures, including the anterior rectal sheath, and passing within the grasp of the interrupted, horizontal sutures passed through the rectus muscle and sheath before their division _ and, before they are tied, the margins of the rectal sheath are brought together by a continuous catgut suture. The vertical portion of the rectal sheath is also closed by catgut sutures.

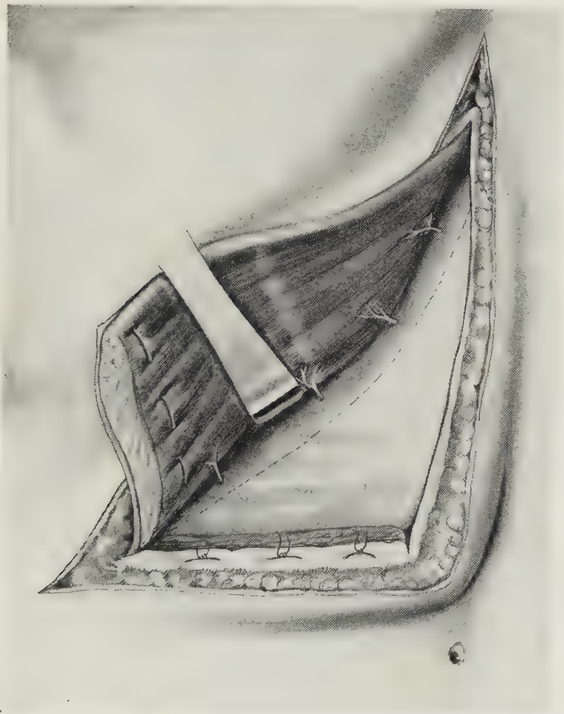


Fig. 3669.—The Same _ II; _ The flap of skin, fascia, anterior rectal sheath and rectus has been displaced upward and backward, over the costal arch. The entry of the intercostal nerves into the postero-external aspect of the rectus is shown. The oblique line, parallel with the costal arch, along which the posterior rectal sheath will be incised, is shown in dotted course.

EXPOSURE OF THE GALL-BLADDER AND BILIARY TRACT BY VERTICAL INCISION JUST WITHIN THE MAMMARY LINE, THROUGH THE EIGHTH, NINTH, AND TENTH COSTAL CARTILAGES AND ABDOMINAL WALL

DOYEN'S TECHNIC

Doyen claims for this procedure a very free exposure of the structures in the hilum of the liver _ which it undoubtedly does. On the other hand, it probably involves an unusually large number of intercosto-abdominal nerves.

The vertical incision begins over the arch of the right eighth costal cartilage, a little to the inner aspect of the mammary line, and passes directly downward

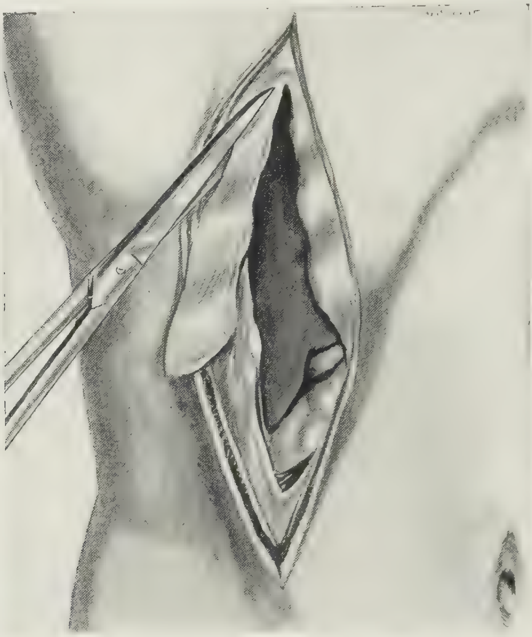


Fig. 3670.—Doyen's Method of Exposing the Gall-bladder and Biliary Tract by Vertical Incision Through the Eighth, Ninth, and Tenth Costal Cartilages and Abdominothoracic Wall; – To which may be added the excision of a narrow, wedge-shaped strip of cartilaginous and intercartilaginous tissues. The lips of the wound are retracted anteriorly and posteriorly, exposing the deep-lying structures in the hilum of the liver and in the gastrohepatic omentum.

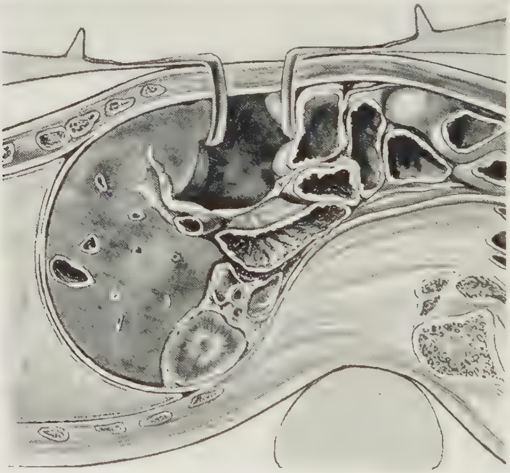


Fig. 3671.—The Same – II; – Upward retraction of the liver and downward retraction of the transverse colon – exposing the field of operation in a vertical direction – seen in sagittal section. (Redrawn from Doyen.)

over the eighth, ninth, and tenth costal cartilages, to terminate upon the level of the umbilicus (Fig. 3670).

The abdomen is opened below the cartilage of the tenth rib – and the cartilages of the tenth, ninth, and eighth ribs are divided in the same vertical line, without wounding the pleural sinus. A certain length of the exposed portions of these cartilages is excised by means of bone-cutting pliers — after which the margins of the wound are firmly retracted, forward and backward, by retractors applied opposite the soft parts of the wound margins — thus affording an unusually free access to the deep structures lying in and below the hilum of the liver, including the hepatoduodenal ligament and the foramen of Winslow.

In order to secure an even deeper exposure fairly broad retractors may be employed in the opposite directions — the upper one displacing the liver upward toward the ribs — and the lower one retracting the transverse colon downward (Fig. 3671).

At the end of the operation the abdominal and thoracic walls are repaired by layer suture, approximating the muscular and aponeurotic planes by means of chromic catgut stitches. The slight loss of cartilaginous substance is not missed in the coming together of the rib ends.

OTHER FORMS OF INCISIONS FOR THE EXPOSURE OF THE GALL-BLADDER TRACT

Bevan's Incision.—The incision is, at first, a vertical one, passing through the fibers of the right rectus muscle at about 2.5 cm. (1 inch) from the median

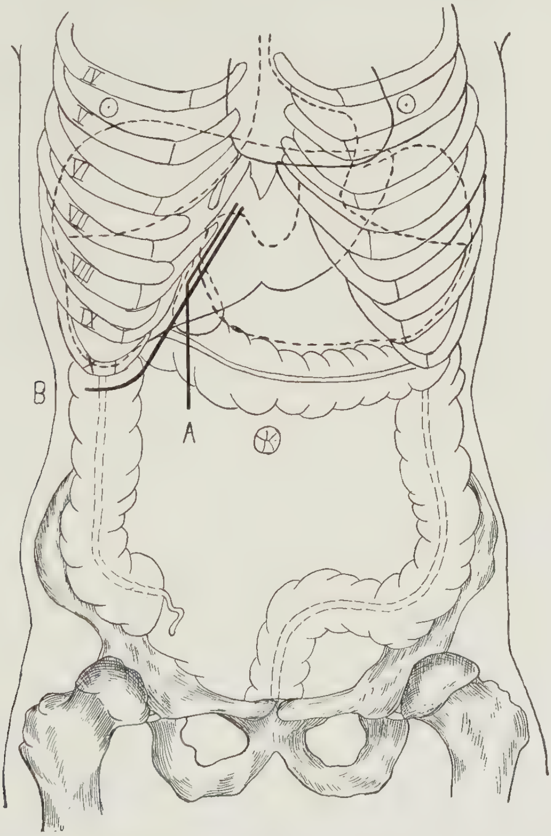


Fig. 3672.—Incisions for Exposing the Gall-bladder and Ducts: — A, Mayo Robson's incision; B oblique subcostal incision. (Modified from Deaver.)

line _ beginning at, approximately, the junction of the seventh and eighth costal cartilages, and extending as far down as may be considered necessary _ and may be all that is needed in thin subjects. If more room for exposure be required, the upper end of the incision is curved forward in the general direction of the xiphoid cartilage. And if still more room be needed, the lower end of the incision may be curved backward.

Sprengel's Angular Incision.—The longer limb of this incision passes downward, from the median line, approximately parallel with the right costal arch _ and from its lower end a shorter incision is carried upward to the costal arch. (The writer has not been able to ascertain the exact points of beginning and ending of the composite incision.) The outer part of the incision divided only the external oblique aponeurosis _ but not the internal oblique, nor transversalis. The anterior rectal sheath, the rectus, and the internal oblique and transversalis are divided parallel with right costal arch.

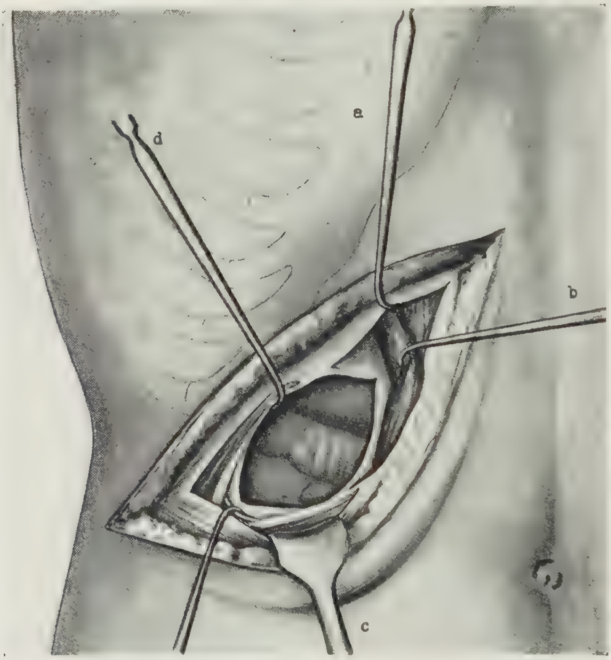


Fig. 3673.—Exposure of the Liver and Gall-bladder Tract by an Oblique, Subcostal Incision _ Followed by Muscle Splitting and Retracting: _ **a,** Anterior layer of the rectal sheath retracted; _ **b,** inwardly retracted outer margin of the right rectus muscle; _ **c,** retracted lower margin of the split external rectus. The internal oblique is seen just beneath the external oblique _ and the transversalis next to the peritoneum, through which the intestines are seen. (This particular association of intermuscular features, in so far as combining retraction of the rectus with splitting of the other abdominal wall muscles, has not been applied, as far as known by the author, to the exposure of gall-bladder tract.)

Lawson Tait's Vertical Incision Through the Rectus Muscle.—This incision extends from the costal arch, directly downward, through the outer part of the right rectus muscle _ and usually furnishes satisfactory access in simple cases. It, however, crosses the course of several intercosto-abdominal nerves.

Mayo Robson's Incision.—This consists of a vertical incision made downward from just below the costal arch, through the outer part of the right rectus muscle _ and from the upper end of which an oblique incision is carried upward and inward, parallel with the right costal arch, to the ensiform cartilage (Fig. 3672, A).

Other methods of exposing the gall-bladder tract have been mentioned at p. 503 _ and have been described and pictured, in detail, under the operations for the exposure of the anterior aspect of the liver pp. 441–444).

An intermuscular form of incision is suggested in Fig. 3673.

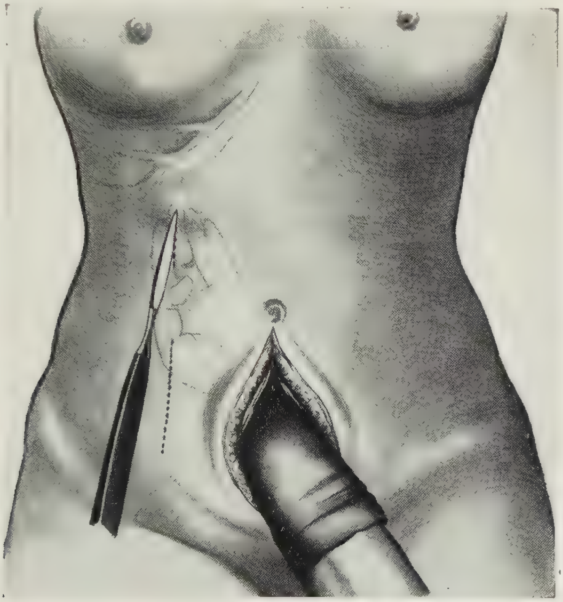


Fig. 3674.—Incising the Abdominal Wall Upon the Finger-tip to Expose the Gall-bladder _ following exploration through a median abdominal section, or through an appendectomy wound (the latter here seen in dotted lines). The knife should be cutting in the opposite direction _ the right-handed Surgeon standing to the patient's left.

An easy method of exposing the gall-bladder, if found to be necessary in the course of an intra-abdominal exploration made through a median incision, is seen in Fig. 3674.

OPERATIONS FOR WOUNDS AND FOR RUPTURE OF THE GALL-BLADDER

Wounds of the Gall-bladder.—The gall-bladder is exposed either through enlargement of the surface wound through which the wounding object entered _ or, acting independently of this, the gall-bladder is exposed by one of the recognized incisions used for that purpose.

The ideal treatment of stab-wounds, and of incised wounds of limited extent, of accessible regions of the gall-bladder, is closure by a through-and-through marginal catgut suture of all the coats, followed by a surrounding seromuscular suture of silk or Pagenstecher. Sometimes a small wound may be infolded by a purse-string suture. This latter may either be a single seromuscular non-absorbable suture, surrounding the lips of the wound _ or it may consist of a double tier, the first being a through-and-through absorbable purse-string suture of all the coats, reinforced by an outlying seromuscular, non-absorbable purse-string suture. It may be a temptation to close without drainage, but as the wound-inflicting object is usually capable of infection, temporary drainage, from outside of the gall-bladder wound, through a part of the abdominal wound, is ordinarily indicated. In some instances the safest policy is to insert a rubber drain into the interior of the gall-bladder, and out through the abdominal wound – the case then being treated, in all mechanical details, as one of cholecystostomy.

In lacerated and in gunshot wounds the nature and amount of damage will usually determine the course to be pursued with the gall-bladder. The suturing up of these gall bladder wounds is often impossible or contraindicated. In some cases of wounds of this nature, involving a prominent, accessible fundus, Doyen's method of partial excision of the gall-bladder may be applied. As a rule, however, if any operation at all can be considered which will conserve the gall-bladder, it usually consists in a combination of partially suturing the wound in the gall-bladder, and then inserting into the remaining portion of the gall-bladder wound a rubber drain, around which the rest of the bladder is drawn, as in cholecystostomy by rubber drain, – and then conducting this drain out of a part of the abdominal wound left unsutured for that purpose. Or sometimes the damaged viscus can be closed by some form of suture, and the wounded portion of the bladder be anchored in the lower plane of the abdominal wound. In these more extensive forms of wound, in which infection is very apt to play a rôle, drainage, even if but temporary, is almost invariably called for – drainage from within the gall-bladder, through the abdominal wound (practically, cholecystostomy) – as well as of drainage of the local peritoneum, from the site of traumatism, through the abdominal wound. Cholecystectomy is often indicated.

Rupture of the Gall-bladder from Disease.—This condition is most apt to be encountered in cholelithiasis and in septic cholecystitis. Its occurrence calls for immediate operation – just as does the rupture of an infected appendix – and better still would it be to operate upon strong suspicion rather than after rupture.

The gall-bladder is exposed by one of the usual methods of approach. Gauze packs are in immediate readiness to protect the neighboring structures from further escape of infected fluid, gall-stones, and bile. If these have already been somewhat generally spread over the peritoneal cavity, the soiled structures should be cleansed by gauze-wipes, suction drainage, in some cases – and, exceptionally, by irrigation with saline solution, if the soiling be marked and universal. All the involved peritoneal pouches should be especially well cleansed, particularly the right kidney pouch.

Closure of a gall-bladder wound caused by pathologic rupture by suture is generally out of the question owing to the insecurity of the weakened margins. The next most conservative step would be in the case of a very limited rupture, to invaginate the ruptured opening around a rubber tube, as in cholecystostomy – utilizing healthy portions of the gall-bladder for the invaginating seromuscular suture. This, or the anchorage of the ruptured gall-bladder into the lower plane of the abdominal wound, offer, practically, the only chances for saving the gall-bladder. It frequently happens in these cases that the wisest step is to totally excise the viscus – the mechanical steps then being the same as those of cholecystectomy – with the added complications associated with the escaped and escaping bladder contents into the peritoneal cavity.

If the gall-bladder be retained, a thorough examination should be made of the biliary tract, in order that the cause of the condition may be ascertained, and, if possible, removed. And where the gall-bladder is removed, the biliary ducts should be similarly examined, to determine their patency.

In all cases of ruptured gall-bladder, temporary drainage of the peritoneal cavity should be instituted.

ASPIRATION OF FLUID FROM THE DISTENDED GALL-BLADDER, AFTER EXPOSURE OF THE VISCUS, PRELIMINARILY TO INCISING ITS WALL OR EXCISING THE ORGAN

The contraindications to exploratorily or therapeutically puncturing the liver through the unopened abdominal or thoracic wall (v. p. 440), apply with even greater force to the puncture of the gall-bladder before the abdominal wall has been incised.

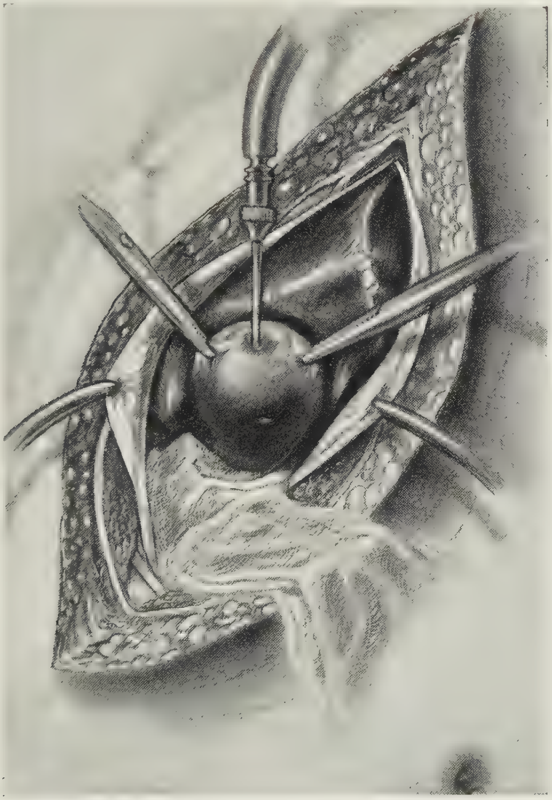


Fig. 3675.—Aspirating the Distended Gall-bladder – to lessen tension, preparatorily to operation upon the organ or ducts.

It is, however, often warrantable – and desirable – to remove part of the fluid contents of a tensely distended gall-bladder after it has been exposed in the course of an operation, before incising the organ – chiefly for the purpose of preventing the often uncontrollable spurting of the contained fluid, with possible consequent infection. More room is thus secured for manipulation – whether for establishing drainage or for excising the structure. The aspirating needle will also often give the additional information of gall-stones in its contact.

The aspirating outfit must be armed with a stout needle of fairly large caliber, as its lumen may be plugged with balls of mucus, or by very thick, ropy bile. All of the surrounding region should, of course, be well protected by gauze pads, that no leakage may soil the peritoneal cavity. The needle is carried carefully through the bladder wall of the prominent part of the fundus by a controlled stab movement (Fig. 3675) _ and in the subsequent manipulations care is exercised to keep the needle in the axis of the gall-bladder, and not to wound (and especially not to penetrate) the opposite wall. Judgment must be exercised as to whether non-flow of fluid be caused by such possible plugging as mentioned above, by excessive thickness of the fluid, or by impingement of the needle upon or engagement in the opposite wall.

When the desired amount of fluid has been removed, and the tensity of the bladder is replaced by a certain degree of flaccidity, the needle is carefully withdrawn _ but not until a clamp-forceps is immediately at hand, with which to close the needle opening, and thus prevent leakage. This clamp is left in place _ and the gall-bladder wall is seized at some nearby site by another clamp-forceps. Thus an elevated ridge between the two clamps is formed _ which is conveniently cut at a right angle to the stretch of the ridge _ the escaping contents of the bladder being caught in some receptacle or upon gauze.

If cholecystectomy is planned to follow partial aspiration of the contents, this is accomplished while the needle opening is clamped or tied by ligature). If drainage is to be established after evacuation of the fluid and incising the wall of the bladder (as well, possibly, as freeing the cavity of calculi), steps for the establishment of drainage are begun as soon as the organ has been emptied of its contents _ and in accordance with the technic described under Cholecystostomy.

CHOLECYSTOTOMY FOLLOWED BY CHOLECYSTORRHAPHY

Description.—Incision of the gall-bladder _ followed by immediate closure of the wound by suture. The incision may be made simply for exploration, and be followed by the removal of gall-stones, if discovered. Or it may be made for the avowed purpose of removing gall-stones, known in advance of the incision to be present. The gall-bladder itself is not drained. Nor is a drain systematically carried down to the site of the sutured gall-bladder, and out through the abdominal wound _ though, when indicated, this is done. Incision and suturing of the gall-bladder are *not* carried out unless the cystic and common ducts are free of obstruction _ this is a *sine qua non* (as the continuation of any blockage would simply be followed by a redistention of the viscus). Nor is cholecystotomy to be performed upon a badly infected gall-bladder. Cholecystendysis is an expression sometimes used to cover the same technic _ incision of the bile-bladder, followed by its suturing.

It is to be understood, from the nature of conditions, that cholecystotomy has but a limited field of application _ for the simple reason that the set of conditions under which it is an ideal procedure is far less frequently encountered than is the opposite set of conditions. It is, however, wrong to consider that cholecystotomy has literally no place in Surgery, and that there are, practically, no conditions under which its performance is warrantable _ as is stated in a number of quarters.

Indications _ Contraindications.—Kocher is a staunch upholder of cholecystotomy, followed by immediate cholecystorrhaphy, in preference to cholecystostomy, or cholecystectomy _ in appropriate cases. He considers it the operation of choice, as well as a relatively simple and safe procedure _ in early cases of gall-stones, without infection of the gall-bladder, and without obstruction in either cystic or common duct. He holds, further, that the operation is more quickly, simply, and safely performed than either cholecystostomy or cholecystectomy _ and is less troublesome from the standpoint of adhesions than cholecystostomy is. The claim that recurrence is more frequent than after cholecystostomy is less apt to be borne out in proportion as cases are selected for which this operation is fitted (that is, non-infected, non-obstructed cases). The removal of the gall-bladder itself does not preclude the formation of another calculus in the biliary ducts, if the conditions exist favorable to their formation.

Landmarks.—The usual site of the fundus of the gall-bladder, opposite the lower border of the right ninth or tenth costal cartilage; the right linea semilunaris. Sometimes the contour of a distended gall-bladder is detectable through a thin abdominal wall.

Incision of Approach.—One of the several mentioned may be chosen (pp. 441–444). The incision of Mayo Robson is a good one. It begins as a simple vertical incision, just below the costal arch, passing downward, over the outer part, or, as carried out by some, over the middle of the right rectus muscle _ and need not at first be more than 7.5 cm. (3 inches) in length. If more room be needed, it can be carried further downward _ and if greater access be desired, the upper end of the incision is carried obliquely inward, parallel with the right costal arch, as far as indicated. Kocher's oblique subcostal incision is also very satisfactory.

Operation.—Having opened the abdomen and systematically examined the gall-bladder, gall-ducts, and head of the pancreas, the region of the gall-bladder is carefully packed off with gauze. The condition of the gall-bladder is examined with reference to its accessibility before the gauze is packed into position _ and the packing should not tend to render it less accessible. As a rule, in cases where cholecystotomy is practised, the fundus of the bladder is usually within easy reach _ rather than contracted and retracted, as in many long-standing cases of gall-bladder disease. If it be distended, part of its contents should be aspirated by needle (v. p. 507) _ to avoid the spurt of fluid which would be otherwise likely to soil the field when the distended organ is incised. When the fluid contents of the bladder have been partially evacuated, the needle is withdrawn _ the needle puncture being immediately seized by one clamp, and an adjacent part of the fundus by another. A ridge is thus formed between the two pairs of forceps _ which is incised by knife or scissors (Fig. 3676) after having made provision for catching the outpouring fluid in some special device (such as Mayo's tray-scoop). The gall-bladder, free of its fluid, can now be drawn even further into the abdominal wound _ and when all dripping is controlled, special instruments for the further steps of the operation should be at hand, such as probes, forceps, scoops, and spoons.

Systematic examination for calculi within the gall-bladder and ducts should be made by combined manipulation of instruments within the passages, introduced through the incised fundus, aided by digital palpation from without _ while the lips of the wound in the fundus are held apart by carefully applied clamps, and the whole organ drawn forward. This examination is independent of the one made before the fundus is incised. While difficulty is sometimes experienced in removing calculi of the gall-bladder and cystic duct, the difficulty is usually not great, in average cases, when the instrument within the bladder is aided by a finger without. Irrigation will often prove helpful in dislodging calculi _ and in cleansing the tract generally. If a calculus be found within the cystic duct not easily removable from the opening in the fundus, an effort should be made to "milk" it outward from the duct into the gall-bladder.

In those cases (exceptional, as they may be) in which it is not indicated to establish drainage, or to remove the gall-bladder entirely, steps are now taken to close the viscus by suture — as where, after opening the gall-bladder, no disease was found to be present, or in an early case of calculi, no infection is considered to be present. Concerning the method of suturing, Kocher advises that the wound in the gall-bladder should be closed as an intestinal wound is closed. His first tier of sutures is of catgut, through all the coats of both lips of the incision — and the second, of fine silk, uniting the serous surfaces only by Lembert stitches. His statement is as follows: — "After extraction of the stones, the wound in the gall-bladder is closed by a double row of sutures, as in suture of the intestine. The deep layer, which should be catgut, includes the whole thickness of the wall, whereas the superficial row, fine silk, unites the serous surfaces only. The gall-bladder is then replaced. The sutures cut through the mucous membrane and remain *in situ* without injury to the

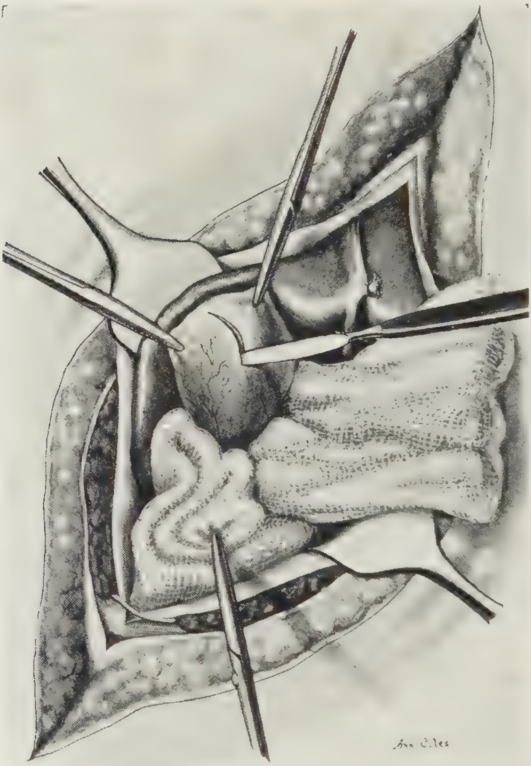


Fig. 3676.—Incision of the Fundus of the Gall-bladder; — The gall-bladder tract has been exposed and packed off with gauze. While the wall of the fundus is steadied by two laterally placed clamps, the fundus is incised by a controlled stab-incision.

If exploratory needle puncture of the gall-bladder cavity be first employed — for exploration or to lessen tension — the needle puncture opening may be at once seized and closed by clamp forceps, using their tips, immediately upon the withdrawal of the aspirating syringe — after which a nearby site of the fundus is seized by a second pair of clamp forceps. The ridged-up wall of the gall-bladder, between the clamps, is then incised by knife, or by scissors, at a right angle to the ridging. Incising, however, directly in the tract of the needle puncture will avoid the necessity for separate closure of the needle puncture subsequently.

serous layer. The wound is completely closed without any drain." The technic is shown in Fig. 3677.

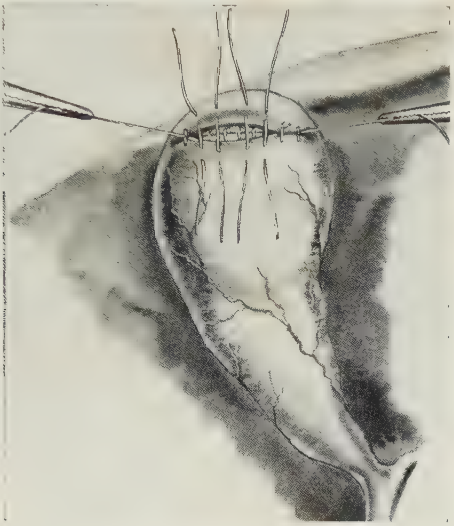
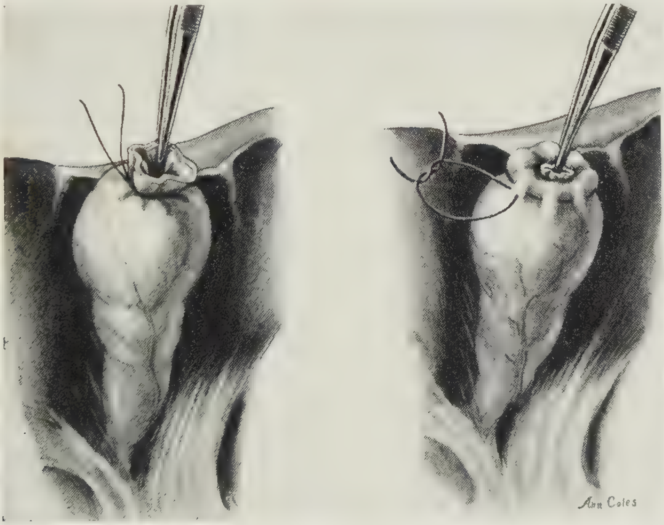


Fig. 3677.—CHOLECYSTOTOMY FOLLOWED BY CHOLECYSTORRHAPHY; _ The margins of the wound have been brought together by through-and-through catgut sutures _ and these are followed by Lembert sutures of fine silk, or Pagenstecher, through the serous and fibrous coats.



Figs. 3678 and 3679.—CHOLECYSTOTOMY FOLLOWED BY CHOLECYSTORRHAPHY; _ The tissues of the fundus, constituting the lips of the incision, are caught and held up by forceps, while a catgut ligature encircles the tissues. The redundant portion of the lips distal to the ligature are excised _ after which the ligatured part is buried, by being inverted within the gall-bladder, by means of Lembert seromuscular sutures of fine silk. This technic may amount to a partial cholecystectomy.

Doyen advises the tying off of the puckered together fundus, just proximal to the incision _ and then to bury this by purse-string suture of the Lembert type _ as shown in Figs. 3678 and 3679.

In ideal cases the sutured fundus is dropped back into the abdomen without drainage or anchorage. In other instances, while not drained – that is, while no form of drain is carried through the abdominal wound down to even the site of the sutured gall-bladder – the gall-bladder is sometimes anchored to the abdominal wall by a couple of seromuscular sutures, so that in the event of subsequent need for drainage, it will be easily accessible. The abdomen is closed in the usual manner.

Comments.—It is an unfortunate fact that not only formerly, but at present, and among the very best men, cholecystotomy and cholecystostomy have been and are used synonomously – without any excuse whatever for such misusage. Cholecystendysis is a cumbersome and inaccurate expression, and should be entirely discarded.

There should be two very thorough examinations of the field (gall-bladder and ducts) – one before the gall-bladder is packed off with gauze, incised, and emptied – and another, with fresh gloves, after its contents have been removed.

One should try to pass a probe from the wound, through the cystic duct, guided by the fingers of the opposite hand in contact with the duct.

It is desirable not to anchor the fundus to the abdominal wall, without especially good reasons for doing so. It invites the formation of additional adhesions.

It is not warrantable (except in emergency) to perform cholecystotomy in two stages by any form of procedure other than one in which the abdomen is first opened and the entire gall-bladder tract thoroughly examined, *before* the fundus is anchored to the abdominal wall to enable it to form adhesions before future opening – for the reasons explained under Comments upon the operation of cholecystostomy, p. 522.

Moynihan, in condemnation of cholecystotomy, as compared with cholecystostomy, writes: – "Since it has been recognized that many of the symptoms, and all the complications of gall-stone disease, are due to an inflammation in the gall-bladder or bile-ducts, it has properly become the custom to drain the bile-passages until the time, varying in different cases, when the inflammatory processes have subsided. The great principle which has to be carried out in gall-stone surgery is drainage. Without drainage there is a risk of imperfect healing of wounds made in the bile-passages, and, therefore, of leakage subsequently of their contents, of small calculi or sand or inspissated bile, or even pus remaining, and of that condition of the mucosa persisting (stone-forming catarrh) which was responsible, in the first instance, for the formation of gall-stones. 'Ideal cholecystotomy' (meaning incision and immediate suturing of the gall-bladder) is anything but ideal in practice, and is an operation that is mentioned now only that it may be unequivocally condemned."

CHOLECYSTOSTOMY FOR CHOLECYSTITIS AND CHOLELITHIASIS

Description.—Incision of the gall-bladder – followed by drainage of its cavity. It is a procedure resorted to for the relief of a large number of conditions of the liver, gall-bladder, biliary ducts, and pancreas – especially infective cholecystitis and cholelithiasis. It was, at one time, distinctly the most generally employed operative measure in connection with the gall-bladder tract – and probably still is the most frequently applied operation – in spite of the present swing, particularly in some quarters, in favor of cholecystectomy in an increasingly large proportion of cases. Two comments, bearing upon the question, are worthy of consideration; – Mayo Robson states: – "It (cholecystostomy) is unquestionably *the* operation to be aimed at in the greater number of cases of cholelithiasis, the operation of cholecystectomy being reserved for the special conditions mentioned later"; _ Kocher (a man standing pre-eminently for radicalism) writes: _ "At the present time there are numerous Surgeons, especially in America, who advocate removal of the gall-bladder in nearly every case of cholelithiasis. This we regard as an extreme view."

In establishing drainage, the fundus of the gall-bladder is, preferably, sutured to some part of the abdominal wall (either into the plane of the parietal peritoneum, for temporary drainage; or into the outer sheath of the rectus muscle, or into the skin, for prolonged drainage) _ after anchoring a rubber drainage-tube between the lips of the incised gall-bladder wall. This is readily accomplishable in cases of fairly large, distended gall-bladders, which reach to the abdominal wall. In cases of small, contracted gall-bladders, or wherever the fundus will not reach the abdominal wall, the intervening connection between the outermost limit of the fundus and the abdominal wall must be secured by a rubber tube, anchored into the cavity of the bladder, and brought out through the abdominal wound (and this latter course is adopted by some independently of the length of the gall-bladder).

The operation was formerly sometimes done in two stages _ anchoring the gall-bladder in the abdominal wound in one, and opening it in another. As now performed, operation is usually carried out as a single-stage procedure.

Cholecystostomy is, as a rule, a simpler and safer operation than cholecystectomy.

Indications for Cholecystostomy.—It may be stated, broadly and to begin with, that cholecystostomy is to be performed in those cases where the need of temporary drainage of the gall-bladder and biliary ducts is indicated. A large number of conditions have been grouped under this heading _ which list is modified from Robson and others: _

1. Following the removal of gall-stones from a non-infected or but limitedly infected gall-bladder of sufficient size for drainage. (A badly infected, contracted gall-bladder should be removed if the common duct be patent.)
2. Following the removal of gall-stones from a non-strictured, non-ulcerated cystic duct. (In strictured or ulcerated cystic duct, cholecystectomy should be done.)
3. Following the removal of gall-stone from the common-duct by choledochotomy, provided the gall-bladder be not markedly diseased, nor the cystic duct obstructed, nor ulcerated. (When the common duct is strictured, or otherwise irreparably obstructed, cholecystenterostomy is indicated.)
4. Chronic catarrh of the gall-bladder and biliary ducts, resulting in clinical phenomena resembling those associated with gall-stones, and which have been unrelieved by general non-surgical measures.
5. Simple suppurative cholecystitis, without marked involvement of the gall-bladder walls.
6. Infective and suppurative cholecystitis, after the removal of the cause of the condition.
7. Hydatid liver disease, with discharge into the biliary ducts.
8. Moderate hydrops of the gall-bladder, where the cause is removable, and the cystic duct non-strictured and non-ulcerated. (In marked hydrops cholecystectomy is indicated.)
9. Some cases of jaundice resulting from compression of the common duct by pancreatitis, and where cholecystenterostomy is not considered indicated.
10. Some cases of cancer of the common duct, or head of the pancreas, often causing jaundice, where, for some reason, cholecystenterostomy is con-

traindicated. (For temporary relief.) (Cancer of the gall-bladder or cystic duct is a contraindication.)

11. Perforation of the gall-bladder, or biliary ducts, from injury or diseases – in conjunction with other surgical measures.
12. Gangrenous or phlegmonous cholecystitis, where the general condition forbids any other procedure (where, otherwise, cholecystectomy would be performed).
13. Specific infections of the gall-bladder, such as typhoidal.
14. When the patient's condition is such as to forbid some other more strictly indicated procedure for the radical removal of the cause of lesion – and where cholemia and general infection are present.
15. As a temporary measure for tiding a patient over an emergency – preliminarily to performing some more radical and technical step later.

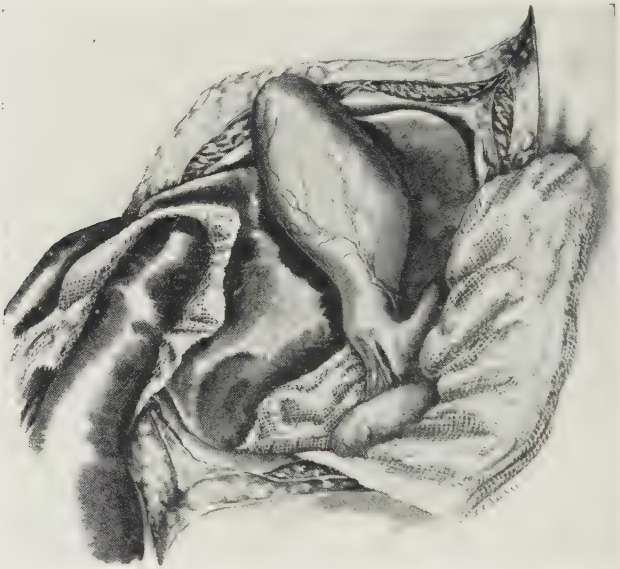


Fig. 3680.—Cholecystostomy – I; – Method of exposing the gall-bladder and biliary tract – Robson's technic. Any adhesions encountered in the field, which would interfere with the technic, are carefully freed. Gauze packing is so placed as to catch any fluid which may escape.

Operation.—The abdomen is opened by one of the methods mentioned for exposing the gall-bladder tract – often planning a more limited incision of entry, in such a way that it may be extended at one or both ends, as the needs of the case may, upon examination, demand – remembering that while a simple cholecystostomy, in a distended, non-adherent gall-bladder may be a very easy undertaking, a complicated case may prove a very arduous task. On entering the abdomen, the gall-bladder, its ducts and the head of the pancreas should be carefully examined – and the nature and extent of adhesions, if any, determined – and, in general, the features of the structures and the difficulties of the impending operation be estimated. The gall-bladder tract may often be helpfully exposed by everting the border of the liver (Fig. 3680). If no adhesions be present, much information should be secured by such examination. If, on the other hand, adhesions be present – which is apt to be the case in complicated cases, especially in long-standing conditions, these will probably serve as barriers to the investigation, and particularly to the subsequent surgical steps – and must, therefore, be systematically sought and separated. Adhesions, according to their nature and density, are generally freed by blunt dissection, by gloved finger, gauze-covered finger, blunt dissector, curved Mayo scissors, or by division between ligatures.

The condition of the patient, combined with the difficulties of the special case, may preclude all other desirable measures, except the one of incision, anchorage, and drainage. But it is exceedingly unsatisfactory to conclude the operation without such thorough examination of the interior of the gall-bladder and the lumina of the ducts, and such examination can only be satisfactorily accomplished through combining manipulation within the gall-bladder, by finger and probe, with digital countermanipulation outside of the bladder and ducts. The removal of the cause (usually obstruction) of the condition (generally infection or calculi, or both) is, naturally, quite as important as removing its result.

In the case of a distended, non-adherent gall-bladder, of average features, its delivery into the field of operation is usually simple. It is, however, a very different matter to deal with a small, retracted, disease-shrunken and adherent bladder – where, besides separating, or ligating and dividing the adhesions which bind it down and to adjacent viscera, its condition, even after being freed, often prevents its being brought into an easy position for manipulation. It is in this category of cases that the Surgeon may be considerably taxed in the matter of mere mechanical manipulation – especially when, in addition to the gall-bladder, the ducts are to be dealt with. It amounts to securing the maximum degree of mobilization which can be safely brought about – and accomplishing the rest through deftness of manipulation.

The regions surrounding the gall-bladder are packed off with gauze-pads, against soiling by leakage when the bladder is incised. A convenient way of immediately surrounding the gall-bladder itself, in those cases where its prominence and mobility are sufficient to admit of the method, is to split a gauze-pad half-way down its middle – draw the bladder through the slit, and cross the free ends over each other. The fundus of the organ is then seized by two clamp-forceps, in the manner already illustrated in Fig. 3675. The ridge raised between these forceps is then incised by knife, or, probably better, by scissors – after making provision for catching the first gush of fluid – along with which may also escape a calculus, or more. The grip of the forceps is then changed, so that each pair now seizes a lip of the bladder opening – and henceforth they serve the rôle of retractors of the lips during the subsequent manipulation within the bladder (Fig. 3681). If the bladder be at all tensely distended, it should be first partly emptied by aspiration as detailed at p. 507.

If need be, the original incision in the fundus may be enlarged, so that such instruments as indicated can be introduced for the extraction of stones – such as spoons, scoops, forceps, and the like. The spoon or scoop is the most generally useful instrument for dislodging stone from the bladder – manipulated as seen in Fig. 3681. The larger scoop is employed to dip the loose stone from the cavity of the bladder, while, at the same time, to keep from spilling the accompanying bile. The smaller scoop will often dislodge a stone impacted within the neck of the gall-bladder. Frequently a stone impacted within the beginning of the cystic duct can be freed from its impaction by manipulating with a small scoop within the bladder – or with delicate forceps – especially if the physical condition of the parts admit of aiding the manipulation within the bladder by digital manipulations upon the outer wall of the bladder or duct. When it is considered that all calculi have been removed, this should be verified – both by examining the interior of the bladder with the finger – and the lumen of the cystic duct with a probe as well as the hepatic ducts and the common duct by digital manipulation, to exclude the presence of other stones. For this purpose the gauze under the gall-bladder is temporarily removed and the fundus drawn upward by the clamps. If a stone be found in an hepatic duct, or the cystic duct, an attempt to "milk" it back into the gall-bladder is made – from which they are afterward removed. The finger which enters the gall-bladder should have a rubber-cot upon it – which is discarded before going on with the rest of the operation – or, better, the gloves should be changed. Finally, the gauze packing is replaced prior to making provision for drainage.

Drainage is most satisfactorily accomplished by means of a rubber tube of special, thick, resistant, non-collapsible wall, rather than of the usual thin, pliable nature, and of about 8 or 9 mm. ($\frac{1}{3}$ inch) outside diameter. From 3.8 to 5 cm. ($1\frac{1}{2}$–3 inches) of the tubing pass within the gall-bladder (according to the size of the viscus). The outer end is conducted through the abdominal wound, and should have ample length to be attached to some device for catching the bile – usually some type of rubber bag, with a piece of glass tubing interpolated somewhere in its course, to enable the Attendant to keep in touch with the progress of drainage. The first step – is to anchor the proximal end of the drainage-tube within the gall-bladder, and to close the lips of the incision around the tube snugly enough to prevent leakage. Irrespectively of the special method of closing the margins of the incision in the fundus of the gall-bladder around the rubber tube, the tube itself is always anchored to the margin of the gall-bladder incision by one (sometimes two) stitches of catgut (generally No. 0), which passes through all the coats of the gall-bladder except the mucosa, and through the wall of the rubber tube, but without penetrating its lumen – as shown in Fig. 3682, a or as seen

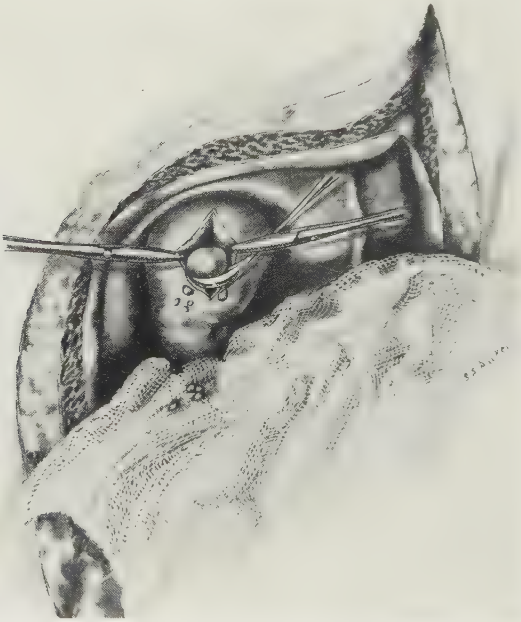
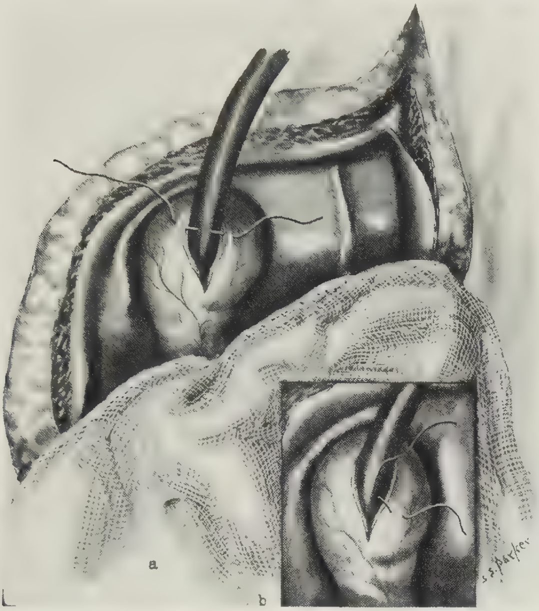


Fig. 3681.—The Same – II; – Removal of stones from the gall-bladder by means of a scoop or spoon. The lips of the gall-bladder wound are held apart by small forceps.



Figs. 3682 and 3682A.—The Same _ III; _ Anchorage of the rubber drainage-tube _ In **a**, the anchorage is accomplished by sutures which penetrate all the coats of the lips of the gall-bladder except the mucosa _ and through the outer part of the wall of the tube. In **b** the Lembert type of suture is employed.

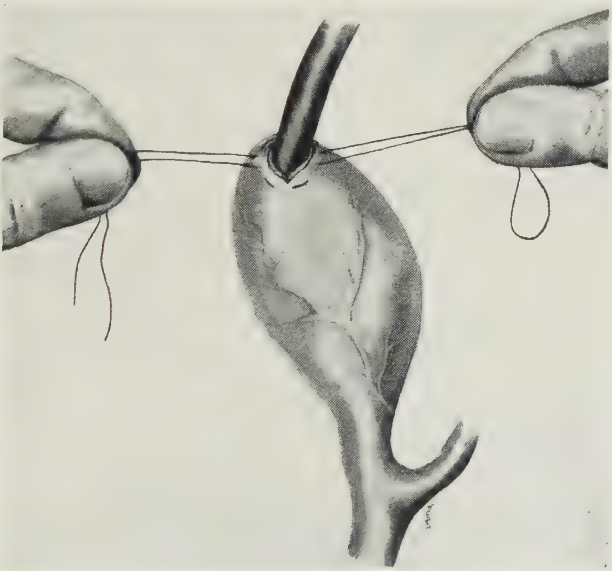


Fig. 3683.—Cholecystostomy; _ Manner of approximating the fundus of the gall-bladder around the depressed rubber tube by the circular purse-string technic _ especially in openings of a more circular aspect _ Summer's method.

in Fig 3682, **b** _ after which it is tied. Having anchored the rubber tube, the opening in the gall-bladder is next closed around the tube _ which may be done in one of several ways. The method most frequently employed for approximating the lips of the fundus incision around the tube is some form of invaginating purse-string suture of catgut – which dissolves within approximately a week or ten days and frees the tube. Summer's method of introducing this suture, especially applicable in more circular openings, is as follows – by means of a curved needle, No. 1 catgut is carried through all the coats of the gall-bladder, except the mucosa, in a circle fully 6 mm. ($\frac{1}{4}$ inch) beyond the incision in the fundus – leaving a loop when half-way around. While the loop is held, on one side, and the free ends, on the other, an Assistant depresses the anchored tube within the gall-bladder (Fig. 3683) – and while he does so, the Surgeon tightens and ties the purse-string – as shown in Fig. 3684. Another method, especially applicable when the gall-bladder incision presents more of the slit-like feature, is to put in several interrupted Lembert sutures of catgut (usually No. 1), through the outer coats only – in the fashion shown in Fig. 3685 – half the number being placed on each side of the rubber tube, so that it will be in the middle of the sutured line. In this method one of the Lemberts, or the one on each side of the tube, may also be the anchoring stitch, or stitches, passing into the wall of the rubber tube. The anchored rubber tube is depressed while tightening and tying the sutures, thus securing the effect of an invagination. Still another, a combination method, is as follows: – a simple draw-string suture of catgut is carried through all of the coats of the margin of the incision, after which the opening is puckered around the tube – and then two or more reinforcing Lembert sutures carried through the outer coats (Fig. 3686). The liver and gall-bladder are now allowed to fall back into their normal position.

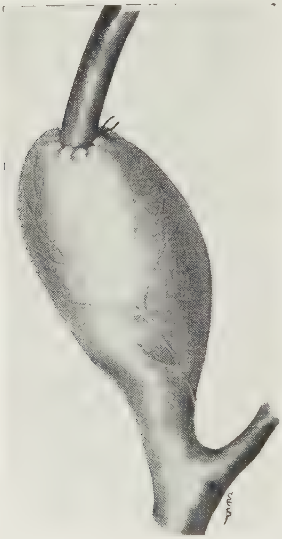


Fig. 3684.—The Same; – The purse-string suture, in Summer's method, has been tightened and tied around the rubber tube.

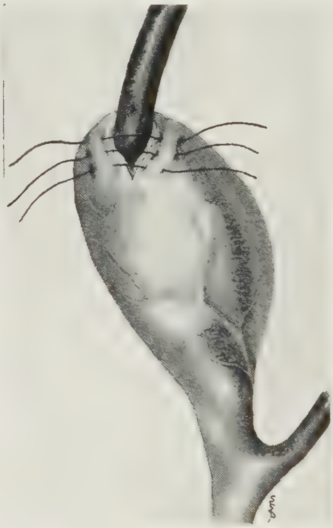


Fig. 3685.—The Same; – Closing the margins of the opening in the fundus around the rubber tube, by means of interrupted Lembert sutures passing through all the coats but the mucosa. Especially applicable in slit-like openings.

The next step is the making of provision for outward drainage of the gall-bladder through the abdominal wall. In the majority of cases, in gall-bladders of average size, the fundus of the bladder will reach the abdominal

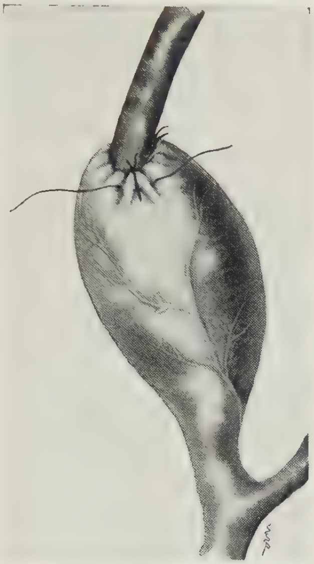
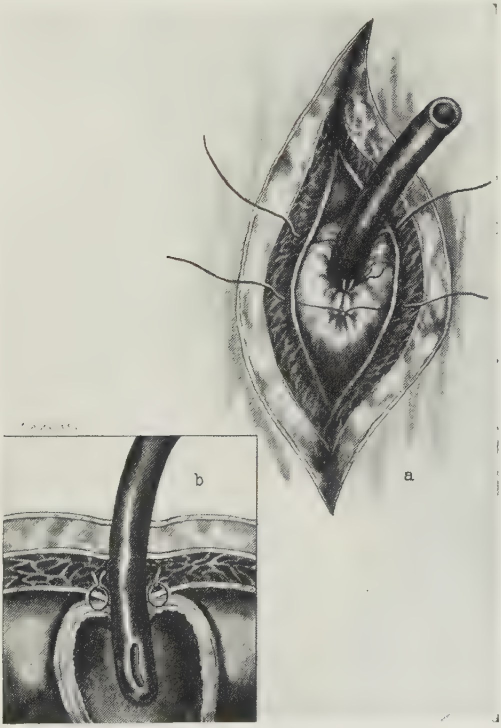
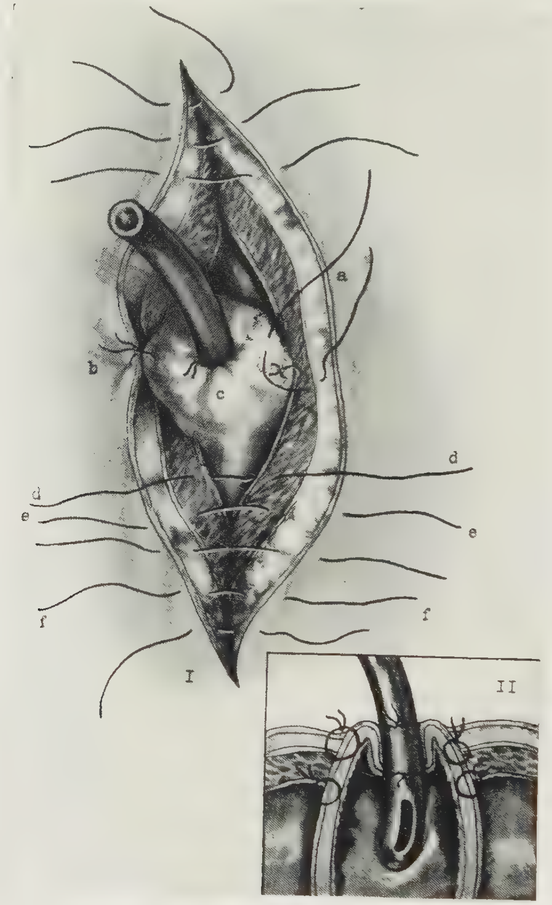


Fig. 3686.—The Same;—Combination method of closing the margins of the opening in the fundus around the rubber drain by, first, a purse-string suture of catgut through all the coats of the gall-bladder—followed, when this is tightened, by two or more Lembert sutures of catgut through the outer coats.



Figs. 3687 and 3688.—The Same;—Anchorage of the fundus of the gall-bladder to the parietal peritoneum and aponeurosis, for temporary drainage:—a, Seen from the surface;—b, seen in sectional view.

parietes. In some cases a small, contracted gall-bladder will not span the distance, so that fundus and parietes cannot be brought into easy contact. (*A*) When the fundus of the gall-bladder will readily reach the abdominal wall, one of two courses is available: – (*a*) The majority of Surgeons anchor the fundus to the abdominal wound. When drainage is meant to be temporary, as is usually the case, the fundus of the gall-bladder is sutured into the parietal peritoneum and aponeurosis by catgut sutures passing through the outer coats of the fundus (avoiding penetration of the mucosa), on the one hand, and the marginal peritoneum and subserous areolar tissue (and the inferior sheath of the rectus, where that is present in the wound), on the other – as



Figs. 3689 and 3690.—The Same; – Anchorage of the fundus of the drained gall-bladder, in the abdominal wound, for prolonged drainage: – **a**, The deeper of the two sutures is a non-penetrating stitch of the gall-bladder wall to the posterior muscular aponeurosis and immediately overlying muscle – and the upper is a similar stitch, anchoring the wall of the bladder to the anterior aponeurosis and immediately underlying muscle; – **b**, the upper anchorage stitch is here shown passing through the skin; – **c**, the upper of two rows of purse-string suture, holding the gall-bladder fundus against the rubber tube; – **d**, **d**, suture of peritoneum, posterior muscular aponeurosis, and part of thickness of adjacent muscle; – **e**, **e**, suture of skin, fascia, anterior muscular aponeurosis, and part of thickness of adjacent muscle; – or, **f**, **f**, suture of skin, where muscles and aponeuroses are separately sutured.

II, Sectional view of the above suturing.

shown in Figs. 3687 and 3688. When the freest and most prolonged drainage is desired – (which, though, is apt to result in biliary fistula, requiring subsequent operation to correct), the fundus is anchored into some part of the abdominal wound nearer to the skin, or directly to the skin margins (preferably to the anterior rectal aponeurosis) – as shown in Figs. 3689 and 3690. (*b*) Some Surgeons, notably Moynihan, do not anchor the fundus of the gall-bladder to the abdominal wound, even when there is ample length of gall-bladder to make the reach. He writes: – "The disadvantage of fixing the gall-bladder to the abdominal wound is that, in some instances, a kink may be produced in the common duct by the dragging of the gall-bladder, and an external biliary fistula result. I invariably allow the gall-bladder to drop back into the abdomen in the manner first suggested by Summers." (*B*) When the fundus of the gall-bladder will not (through contraction, retraction, adhesions, size, or otherwise) reach the abdominal wall – or in those cases where the Surgeon *elects* not to adopt the method of anchorage into the abdominal wound; – In such cases the gall-bladder, with its inserted rubber drainage-tube anchored into the incision in its fundus, is simply dropped back into the abdominal cavity, to assume what position it will – and the necessary gap between the fundus and the abdominal wound (through which the drain passes) is bridged by the rubber tube alone. No harm, however, usually results, for, with a water-tight closure of the fundus around the tube, peritoneal adhesions of the adjacent parts will form around the rubber tube within the succeeding twenty-four or forty-eight hours, completely walling off

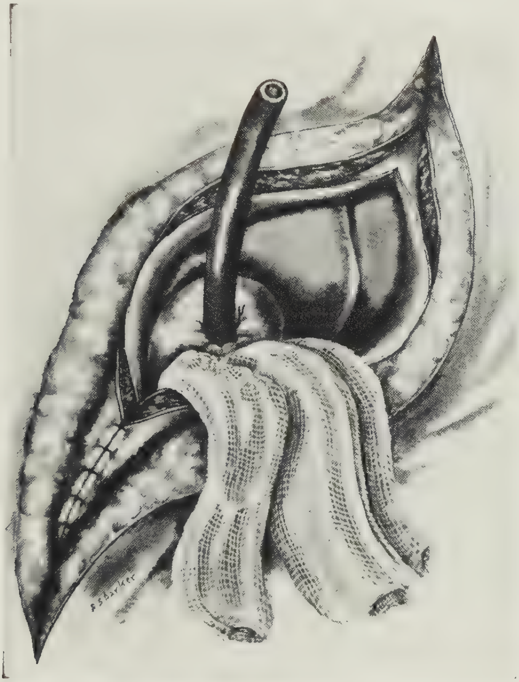


Fig. 3691.—The Same; – Rubber drainage-tube and strips of gauze traversing the distance between the fundus and exit of the abdominal wound, and emerging from the latter. Several untied sutures are usually left in position, for approximating the margins of the abdominal wound after the withdrawal of the gauze drain.

the tube in its course between the fundus and the abdominal wound _ thus cutting off all leakage into the general peritoneal cavity. The rubber drain is, however, usually surrounded by strips of gauze, to catch any possible leakage _ three such strips, surrounding the tube and brought out through the abdominal wound, are shown in Fig. 3691 _ and a sectional view of the technic is seen in Fig. 3692.

The abdominal wound is closed up to the exit of the composite drain. The strips of gauze are generally withdrawn within three or four days. The catgut sutures anchoring the rubber drain, and binding the lips of the fundus incision around the tube, are generally dissolved during the second week, liberating the tube, which is then withdrawn _ by which time a peritoneally bounded *conduit* has been substantially walled off, which serves every purpose for the remaining time drainage continues. If one or more sutures have been passed at either end of the space left for the gauze to come through, at the time of operating, when the gauze is withdrawn, these may be tied _ just leaving room for the exit of the rubber tube. The writer has frequently successfully practised this technic, in the usage of combination rubber tube and gauze drainage, in abdominal wounds _ with, as a rule, union of the then granulating wound margins, thereby curtailing the period of wound closure, and lessening the risks of postoperative hernia.

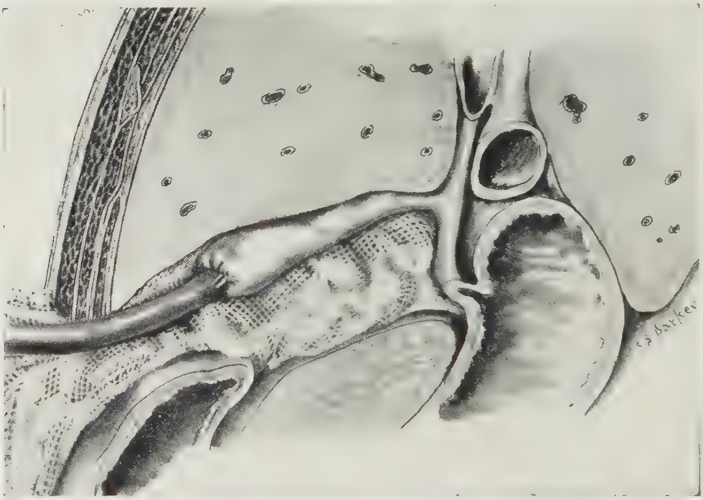


Fig. 3692.—Gall-bladder Drainage, Where the Gall-bladder Will Not Reach to the Abdominal Wall; _ The intervening space is bridged by rubber tubing, reinforced, or surrounded by gauze packing.

The fistulous tract finally left, after the rubber tube comes away, usually soon closes.

Comments.—Some operators do not insert the rubber drain more than from 1.2 to 2.5 cm. ($\frac{1}{2}$–1 inch) into the gall-bladder.

The fundus of the gall-bladder should not be sutured to the skin, unless very prolonged drainage is desired, as a permanent fistula is apt to result.

The catgut anchoring the tube to the gall-bladder is usually absorbed by the end of the first week, or within the ten days _ before which time, the abdominal wound has ordinarily healed _ and the temporary fistulous tract, following the withdrawal of the tube, usually heals within a week or ten days of its withdrawal (provided the ducts are patulous for drainage into the normal channel).

When the liver has receded under the ribs, and the gall-bladder is small, and retracted in its fossa, and intra-abdominal fat and adhesions block the way, the operation may be materially more difficult than where the liver and gall-bladder are prominent and the latter distended.

The parts may be exposed with additional facility if Robson's technic be adopted _ of displacing the liver downward, by slight traction, then elevating, everting, and rotating its lower border in the grasp of a gauze-covered hand. In this way the cystic and common duct tend to be drawn into a straight line from the bladder to the duodenum _ making the biliary tract more accessible to both vision and palpation. In this position, if it be necessary, the peritoneum may be incised over the common duct, in the free border of the lesser omentum, and be separated from the hepatic artery and vena porta. All of these maneuvers are further aided by the support beneath the patient's back (v. p. 393) _ together with some degree of the reversed Trendelenburg position.

In removing the stone from an incised gall-bladder, such evacuation is aided by combining the usage of the scoop with a finger introduced beneath the structures, followed by a forward "milking" movement along the cystic duct and gall-bladder.

If all efforts fail to extract an impacted calculus from the cystic duct by manipulation by spoon and forceps from within the bladder, then an incision must be made into the duct and the stone removed (v. p. 571) _ after which, if the duct be free (as determined by probe), and non-diseased, the incised duct is sutured. The hepatic and common ducts are also probed through the incised cystic duct.

When the final gauze pads are removed, prior to closing, a careful toilet of the peritoneum in the neighborhood of the field of operation, should be made.

In cases when the fundus of the bladder will not reach the abdominal parietes, Robson has been in the habit of suturing the right border of the omentum to the gall-bladder by one or two stitches, so as to construct a peritoneal channel from the bladder to the abdominal wall, to take the place of the rubber tube when that comes away.

In cases where soiling of the right kidney pouch, as is apt to happen when the ducts are opened, or extensive adhesions separated, he carries out a postero-external drainage through a stab-wound made in the right loin from 7.5 to 10 cm. (3–4 inches) to the outer side of the original abdominal incision. The gall-bladder drain is made in the way described, and the peritoneal drain consists of a split, perforated tube, in which a twist or roll of gauze is placed. Both drains are brought out of the posterior wound, side by side _ and the original wound of entrance closed. The peritoneal drain is usually changed within twenty-four hours _ and removed within forty-eight hours. Delayed union through the posterior wound, as a result of the peritoneal drain, is not so apt to be followed by hernia.

Operation in two stages is now far less often performed than formerly. This, when practised, is done in one of two ways: _ The abdomen is opened down to the peritoneum, which is not incised, but gauze is packed into the wound, down to the peritoneum and allowed to remain *in situ* for several says, during which time adhesions form between the gall-bladder and the parietal peritoneum _ after which the gall-bladder can be opened and drained without involving the peritoneal cavity. Or the gall-bladder may be regularly exposed and its general environment examined _ after which the excess of the abdominal wound is closed from either end, and the fundus of the gall-bladder is sutured into the remaining opened portion of the parietal wound, by interrupted, rather fine, chromic catgut sutures — passing through the serous and muscular coats of the gall-bladder, on the one hand, and through the parietal peritoneum and adjacent transversalis fascia, or muscular aponeurosis, on the other, — and then, when adhesions have formed, within two or three days, the fundus is incised, the contents of the bladder emptied, and drainage established — with no fear of soiling the general cavity. The latter method is, by all odds, the better (except in cases of extreme emergency) — as it is the only course which admits of visual and digital examination of the gall-bladder tract, for it would be unsurgical to drain the gall-bladder while obstructing stones might be left in some of the biliary ducts.

Robson considers that the only warranty for the two-stage operation is in the case of a very ill patient where the operation is performed in a state of chronic jaundice, with hemorrhagic tendency and distended gall-bladder — a condition generally associated with malignancy of the head of the pancreas or of the bile-ducts. In such cases hemorrhage from the abdominal wall can be controlled by packing, when the peritoneum has not been incised — and often not by forceps pressure, if the complete opening be made (in which latter case pressure by packing cannot be used).

Cholecystostomy is the safest operation upon the gall-bladder as far as immediate mortality is concerned — over 3000 non-malignant cholecystostomies in the hands of the Mayos, Kehr, and Robson, having furnished a death-rate of 1.8 per cent. In malignant disease the mortality following operation ranges from 10 to 40 per cent.

If puncture be made in advance of incision into the gall-bladder, it is to be remembered that the needle, after withdrawal, is, in infected cases, a septic instrument. The same is true of gloves which have touched escaping fluid, or the mucosa of the biliary tract — as well as gauze packs.

Where the interior of the bladder is filled with a sand-like deposit, this may be removed by swabbing out the cavity with a piece of moist gauze upon an applicator, or held in forceps.

The finger should always be passed through the foramen of Winslow, into the lesser peritoneal cavity, and the structures in the gastrohepatic ligament palpated between thumb and first finger (as explained at p. 491), before considering the examination of the gall-bladder tract complete.

In freeing adhesions one must always bear in mind that such adhesions sometimes conceal a fistulous communication between the gall-bladder and some part of the intestinal tract.

The regions to be protectively packed with gauze pads, in operating upon the gall-bladder tract, are, the hepatorenal recess or pouch; over the pyloric end of the stomach; and over the right aspect of the transverse colon and omentum — apart from those packed about the structure being immediately operated upon.

A good form of rubber tubing is one with an outside diameter of about 8 mm. ($\frac{1}{3}$ inch) and a lumen of at least one-half the total diameter — which is much thicker walled than the ordinary tube.

The most convenient way of making provision for receiving the drained-away bile, is to attach the distal end of the rubber tube to a thin rubber bag, such as are made for the purpose, or such as may be improvised — and then to include this in a dressing attached to some dependent part of the patient's body, in such a position as to favor drainage. When the receptacle merely rests in the bed, near the patient, mishaps are apt to occur — and even more so when the tube passes to a bottle beneath the bed, as so often suggested.

Unless the receptacle be attached to the patient's body, it must be lifted and changed whenever he turns upon his left side, and often in even shifting from back to side. The glass tube above mentioned, interposed somewhere in the course of the rubber tubing, enables the progress of drainage to be conveniently watched.

It is to be remembered that it is possible for sepsis to travel backward along the drainage-tube from its open distal end, and, conceivably, actually involve a biliary tract which was not infected, or had ceased to be infected. This si one reason why it is advantageous to let the tube drain into a rubber bag tied closely around the tube, rather than into an open receptacle _ for the bag is so readily sterilized. Special drainage devices are also made for these cases to catch the bile after it comes from the abdomen.

Some Surgeons attach a piece of glass tubing to the end of the rubber drainage-tube which goes into the gall-bladder _ and tie the margins of the incision in the fundus around the glass tube _ which might be better than tying in a very thin walled rubber tube, which might partly collapse shortly after, and allow leakage.

Special forms of gall-bladder drains, on the Murphy-button order, with one of the buttons prolonged into a long tubular piece, are also sometimes employed _ to take the place of the tied-in rubber tube drain.

If gauze strips have been brought out of the wound along with the drainage-tube, the strips are usually removed at the end of the third or fourth day _ leaving the tube alone. When the tube is removed, toward the latter part of the second week, the fistula usually soon heals. Its continuance beyond two or three months constitutes a biliary fistula _ which may have to be met by special operation.

Calculi have sometimes been very successfully removed from the opened gall-bladder by means of the suction drain, with special, cup-shaped tips of different sizes and curves.

The proximal end of the rubber drain is sometimes anchored within the gall-bladder in the following way: _ First, it is anchored by the single stitch of fine catgut, _ next, a purse-string suture of the same material is passed through all the coats of the margin of the incision, _ finally, a second purse-string suture of catgut, outlying the first, is passed through the outer coats (only), as the margin of the opening is being inverted by depressing the tube.

Some Surgeons wrap the rubber tube in several thicknesses of gauze, and surround the gauze with a layer of rubber tissue. Some operators also depend entirely upon the suturing or tying of the drain in the fundus of the gall-bladder, and omit the anchorage suture.

The strips of gauze which are often made to accompany the rubber drain from the fundus out through the abdominal wound are frequently omitted (especially in clean cases) _ letting the rubber tube alone span the distance _ whether the gall-bladder be stitched to the abdominal wall, or dropped back into the abdomen.

It is said that if the drainage tube be led out through the upper angle of the wound, biliary fistula is less apt to occur.

Sometimes the strips of gauze which accompany the tubal drain are anchored by a non-penetrating suture of fine catgut carried through the outer coats of the gall-bladder. It is well to place some of these gauze strips in such dependent position as to prevent adhesion between gall-bladder and intestine _ and, also, so as to catch any leakage from the fundus.

In disposing of the protective gauze pads, wrung out in salt solution, Deaver and Ashhurst suggest the following arrangement: _ one subhepatically, in the right kidney pouch _ a second, mediad, walling-off the stomach _ a third, between the gastrohepatic omentum and the left lobe of the liver _ a fourth, toward the cecum _ and a fifth, over the right lobe of the liver, to protect the subphrenic space.

Sponge-holding forceps, or other special non-traumatizing forceps, make a good instrument for drawing the fundus of the gall-bladder into the field, especially if not otherwise easily deliverable.

An evacuating trocar and cannula may be used in the preliminary emptying of a distended gall-bladder _ instead of the aspirating syringe _ especially where very much fluid is present.

When the ducts are being examined, after the evacuation of the gall-bladder contents, the cavity of the gall-bladder, or, at least, its incised mouth, should be temporarily packed with gauze, so that no leakage will soil the wound.

If, during examination, a stone within the cystic or common duct cannot be digitally pressed into either gall-bladder (and removed), or into the duodenum, an incision must be made into the duct and the calculus removed _ the technic being as described in the section upon the Biliary Ducts.

During the general examination, not only should the head of the pancreas be palpated, but the pancreas should be examined throughout its entire length _ which should include an examination for lymph-nodes in the gastrohepatic omentum _ at the union of cystic and common ducts _ and at the union of the supraduodenal and retroduodenal portions of the common bile-duct.

It is to be remembered that bleeding may occur from the vessels of the gall-bladder, cut in incising the fundus _ unless the cut margins are subsequently controlled in the process of anchoring and burying in the rubber-drain. Any visibly bleeding vessel is, of course, tied.

In invaginating the margins of the gall-bladder incision around the rubber tube, a little instrument upon the "tucker" order is useful _ at the same time that the fundus is being counterdrawn upon by two forceps grasping it outside of the circle of invagination.

One of the special objects accomplished by this invagination of the margins of the opening in the fundus is that, upon withdrawal of the drain, the valve-like opening left in the fundus, the opposite sides of which are peritoneal, will tend to quickly close, and prevent a fistula.

Whenever, because of thickness of wall, or inaccessibility of a retracted fundus, it is not possible to invaginate the margins of the incision around the rubber tube, then the borders of the opening must be sutured around the tube as snugly as possible _ and it is in such cases, particularly, that the secondary and additional drain of gauze strips is indicated.

The average time of the coming away of the tube is at the end of the second or beginning of the third week.

The gall-bladder tube should make its exit from the abdominal wound in such position as will best serve drainage, but if the upper part of the wound be compatible with this, it is held, by some, that biliary fistula is less apt to result.

A right-angled glass piece may connect the gall-bladder drain with the longer tube passing into the receptacle for the bile _ which is sometimes hung, or pinned with a safety-pin, at the side of the bed. Provision must be made for the patient's turning.

The most favorable test for the limit of drainage is the securing of bile pronounced sterile by cultivation.

When prolonged drainage is desired _ and it may be necessary for several months _ the fundus should be sutured to the anterior sheath of the rectus _ instead of to the parietal peritoneum and transversalis fascia, as already mentioned.

In patients in particularly bad condition, cholecystostomy, under analgesia, is often the only operation he can be safely subjected to, at that immediate time _ although, strictly, some more elaborate, time-taking technical procedure may, from other standpoints, be indicated.

Some Surgeons, in completing the operation, prefer to simply wipe out the interior of the gall-bladder with gauze, wrung out in warm normal saline and held in a gauze holder, using it mop fashion _ while others irrigate the cavity.

If, on incising the abdominal wall, the fundus of the gall-bladder be found adherent to the parietes, it has usually been the custom, formerly, to consider it a fortunate circumstance _ the bladder being at once incised and drained without danger of infecting the peritoneal cavity by surgical manipulations. But such course only admits of securing the limited information which may be gotten by the finger or instrument within the gall-bladder. It must rest with the Surgeon, in connection with the features of the individual case, whether it be not wiser to separate such adhesions as may be thus encountered _ and then conduct the operation in the usual technical manner.

As the mucosa of the gall-bladder bleeds rather readily, it is sometimes necessary to temporarily pack it with gauze, or douche it with fairly hot saline, in order to control the bleeding before proceeding.

In operating in one stage, the gall-bladder may be tied with a purse-string around a flanged glass tube, which is then brought out of the abdominal wound; or a Murphy button with long cylinder may be used. The tube, or button tied in, sloughs out in a few days, by which time adhesions have shut off the cavity.

In operating by the oblique subcostal incision, one may try to expose the gall-bladder through an intermuscular separation of the external oblique, internal oblique, and transversalis muscle, in the triangular space bounded by the eighth nerve running along the costal arch, the ninth nerve running transversely inward from the level of the lower border of the ninth costal cartilage, and the linea semilunaris.

For collateral bearings upon the subject of cholecystostomy, see the operation of cholecystectomy, under Description, Indications, and Comments, p. 533.

CHOLECYSTENTEROSTOMY

Description.—The anastomosis of the gall-bladder with some portion of the intestinal tract, usually the duodenum (sometimes to a loop of the jejunum, or hepatic flexure of the colon) _ for the purpose of carrying the bile to the intestine, in those cases where its normal passage along the common duct is impeded by some form of irremovable obstruction. The principle of the procedure is shown in Fig. 3693 _ where either a calculus, or a stricture (or compression) is supposed to be blocking the common duct. The anastomosis, therefore, may constitute either a cholecystoduodenostomy, cholecystojejunostomy, cholecystocolostomy _ and even cholecystogastrostomy (cholecystopylorostomy) may be performed.

The anastomosis is usually accomplished by methods of simple suturing _ but union is sometimes performed by such mechanical means as the Murphy button, and the like.

As a result of the operation, a new route for the passage of bile from the gall-bladder to the intestine is formed _ which is generally permanent (as where the cystic or common duct is strictured or blocked by stone) _ but may be temporary (as when a pancreatitis, of the head of the pancreas, compresses the common duct – in which case cholecystostomy may also be performed). The cause of obstruction is not removed, but a new channel is conducted around the obstruction. Sometimes, however, in conjunction with cholecystenterostomy, a radical operation is performed for the removal of the cause of obstruction – as well as making provision for the temporary short-circuiting or changed circuiting of the bile.

While both cholecystostomy and cholecystenterostomy make provision for the escape of bile while some obstruction exists to its normal flow, they differ in this material respect – that, in cholecystostomy, the bile is lost to the patient, by its external escape – while, in cholecystenterostomy the bile is diverted into the intestine and saved to the patient for digestive and other purposes.

Cholecystenterostomy is sometimes performed upon a patient in poor condition, when, upon purely surgical grounds it would be more technical to remove a removable cause of obstruction – planning the more radical operation for a more propitious time. Cholecystenterostomy, however, must not be lightly undertaken, because of the ever present danger of septic infection from the intestine.

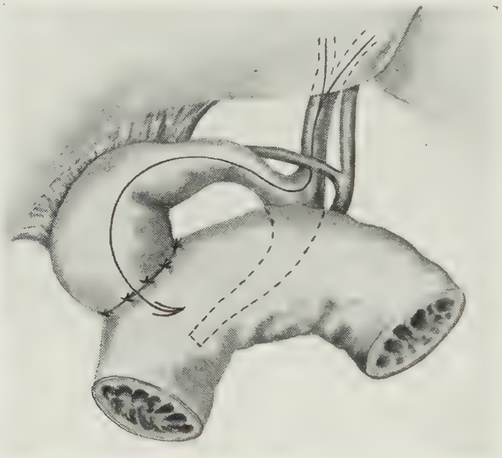


Fig. 3693.—Illustrating the New Course of the Bile from the Liver Into the Duodenum Following Cholecystenterostomy.

Indications for Cholecystenterostomy.—Briefly, the outstanding indication is the existence of some obstructing condition which prevents the bile from passing through the common duct – and which cannot be removed. In greater details, such conditions are the following: –

1. Gall-stone, stricture, or tumor of the common duct – of such nature as to be unremovable by operation. Even in these cases, however, Kocher states that one should consider the possibility of resecting the common duct and performing a duodenoneostomy.

2. Obstruction, which, though temporary, might cause, in the establishment of external drainage, such a loss of bile, over such a period, as to prove fatal.

3. Tumor of the head of the pancreas, or interstitial pancreatis – tending to produce chronic jaundice.

4. Rupture or wound of the common duct of such a nature as to make its repair without obliteration impossible or unlikely.

5. External biliary fistula, either operative or pathologic, of such a nature as to render impossible the restoration of the normal bile route – the method of internal biliary fistula being chosen in preference.

6. Some cases of gall-bladder distention, where both cholecystectomy and cholecystostomy are contraindicated.

Contraindications: –

1. Strictural obliteration, or construction of the cystic duct associated with enlargement of the gall-bladder – (cholecystectomy being preferable).
2. Retracted, contracted, atrophied gall-bladder.
3. Obstruction by gall-stones.
4. Distention of the gall-bladder from malignant disease of the common bile-duct or of the head of the pancreas.

An observation which Kocher stresses may be here mentioned: – "Once more let us repeat, for the benefit of those who advise excising the gall-bladder as a routine procedure, that in those cases where an internal fistula is indicated, one is fortunate if cholecystectomy has been avoided at a former operation, as a cholecystenterostomosis is much easier to perform than a cholangiostomosis." Another bearing upon the subject has been made by Lennander – that a cystic duct which may seem to be obliterated at the time of the operation, may become patulous within a few hours or days when the tension of gall-bladder distention is relieved.

Methods of Anastomosing the Gall-bladder with the Gastro-intestinal Tract.—The following anastomoses are employed: –

(*a*) Cholecystogastrostomy.
(*b*) Cholecystoduodenostomy.
(*c*) Cholecystojejunostomy followed by jejunojejunostomy.
(*d*) Cholecystocolostomy.

The technic of anastomosis is generally by simple suturing – though junction by such mechanical means as the Murphy button is sometimes employed.

Cholecystogastrostomy.—Union of the gall-bladder with the pyloric aspect of the stomach (just to the cardiac side of the pylorus) has been carried out in a number of cases – and, apparently, without harmful results – in spite of the undesirable emptying of the bile into the stomach, instead of intestine. The anastomosis, however, is the least desirable of those mentioned – and should certainly not be employed if it be possible to carry out union with any part of the intestinal tract.

The general features of the union are illustrated in Fig. 3694 – but as the technical details of the anastomosis are precisely the same as those employed in cholecystoduodenostomy (see below), they will not be separately described here.

Cholecystoduodenostomy.—This is the operation of choice – the bile being emptied into the intestine in practically its normal part – and the artificial spanning of distances being the least in this method of anastomosis. The fundus of the gall-bladder is united with the duodenum at the junction of its first and second parts.

The abdomen having been opened, the structures of the involved region examined, and the field packed off, test is made of the ability to approximate the fundus of the gall-bladder to the junction of the first and second portions of the duodenum without too great tension – and if not, sufficient mobilization of gall-bladder (if bound by adhesions), or of duodenum, or of both, should be made.

I. Cholecystoduodenostomy by Simple Suturing, aided by clamp-control of the viscera, is accomplished in the following manner: – If the gall-bladder be distended, it should be preliminarily emptied by puncture and aspiration.

The fundus of the gall-bladder and the free aspect of the duodenum, at the junction of its first and second portions, are seized with special clamps of slight concavity (great concavity interfering with the steps of the operation) — in such manner as to bring into convenient contact the prominent opposite aspects of each (Fig. 3695) — after which the two viscera are united in exactly the same manner as in entero-enterostomy by lateral anastomosis. A posterior row of continuous Lembert suturing, made with Pagenstecher, or silk, is introduced through the serous and muscular coats of the two viscera, along their posterior aspects, leaving the threads long at both ends and one end threaded. Both viscera are then incised, parallel with this line of suturing, about 8 mm. (¾ inch) in front of it, and for about 18 mm. (¾ inch) in length — after which the margins of the openings are whipped together by an over-hand continuous stitch of catgut, including all the coats. The line of continuous Lembert suturing is then carried around the anterior aspect of the wound — completing the anastomosis. The parts are then returned to the abdomen — which is usually closed without drainage.

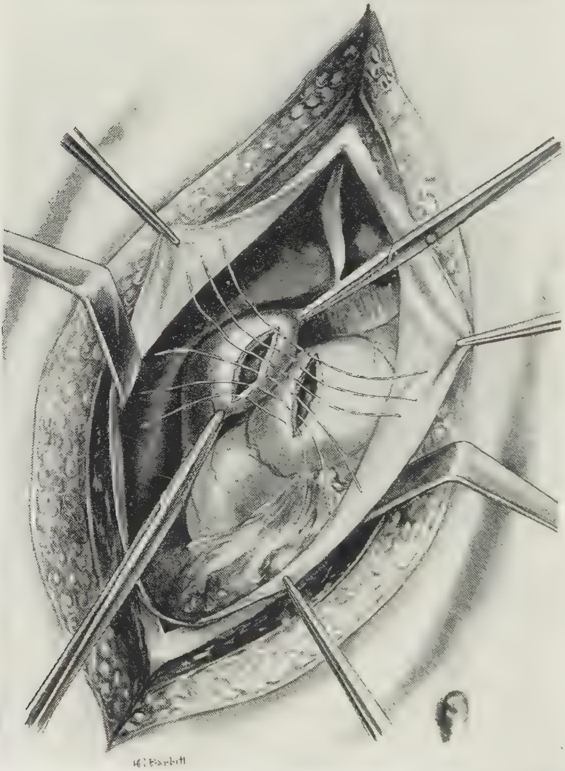


Fig. 3694.—Cholecystogastrostomy by Simple Suturing — I; — The fundus of the partially empty gall-bladder and the pyloric aspect of the stomach have been brought into convenient relationship for the suturing together of the opposite openings — by means of marginal through-and-through sutures, which are represented by the three lower stitches — and by outlying seromuscular sutures represented by the three upper stitches.

Several variations of technical details may be employed in making the anastomosis. Instead of clamping the viscera, they may be digitally held in contact. Instead of adjusting the surfaces or margins to be sutured, by means of forceps, as one progresses, they may be clamped either by tenaculum forceps or by ordinary forceps. It is rather better not to use forceps which penetrate all the coats, as the tenaculum forceps do, as there may result leakage through the holes of the forceps' teeth, into the space between the two tiers of suture ‗ which may eventually find its way into the peritoneal cavity. Instead of using any form of instrument, sometimes thread-tractors are placed either through the outer coats (to steady the parts for the seromuscular suture) ‗ or through the margins of all the coats (to steady the margins for suturing). Both tiers of sutures may be interrupted ‗ or continuous. The penetrating tier is always absorbable.

II. Cholecystoduodenostomy, by the Murphy button, is carried out as follows: ‗ At one time anastomosis between gall-bladder and duodenum by button, bobbin, or the like, was the method of choice ‗ though now it is less frequently employed than anastomosis by simple suturing. Retained buttons and contracted openings following their use have been reported.

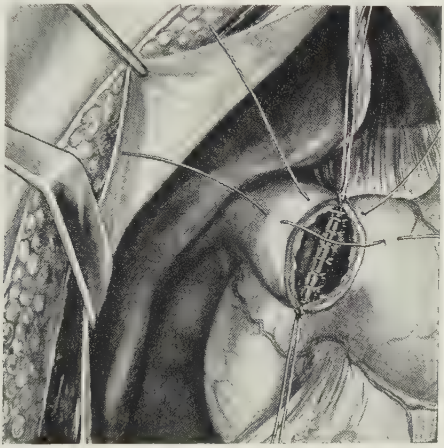


Fig. 3695.—The Same ‗ II; ‗ The fundus of the partially emptied gall-bladder and the junction of the first and second portions of the duodenum have been brought into convenient relationship ‗ after which the posterior line of Lembert suturing is placed, while the walls of the viscera are steadied by dissecting forceps ‗ and an opening is then made in each viscus.

Operation.—The steps of the operation are not essentially different from Entero-enterostomy by the Murphy button. The abdomen having been opened, the gall-bladder and duodenum are exposed ‗ and trial is made to ascertain that both structures can be brought into the field and approximated without too great tension. The field is then packed off with gauze. If the bladder be very much distended, the distention is lessened by partial aspiration, that the contents may not be thrown out over the neighboring parts on incising the viscus. The regular purse-string suture is then introduced through all the coats of the gall-bladder, calculating to so place it upon the prominent fundus, or the inferior surface of the gall-bladder, as to make the best approximation with the duodenum without tension (Fig. 3696). The bladder wall is then incised between the lines of the purse-string suture for a distance equal to two-thirds of the diameter of the special button. The male button, grasped in the usual manner, is insinuated into the opening in the gall-bladder and the walls of that viscus drawn about the cylinder of the button and tied. The female button is similarly introduced into the free aspect of the duodenum and tied. The halves of the button are pressed together — thus completing the cholecystoduodenostomy. If reinforcing Lembert sutures are considered necessary, they are applied. Unless special cause for drainage exists, the abdomen is closed as after ordinary abdominal section.

Cholecystojejunostomy Followed by Jejunojejunostomy.—If cholecystoduodenostomy cannot, for one reason or another, be performed, anastomosis of the fundus of the gall-bladder with the highest available loop of the jejunum, followed by a jejunojejunostomy several inches below the cholecystojejunostomy, is the operation of second choice. The fundus of the gall-bladder is united with a loop of the jejunum about 46 cm. (18 inches) from the duodenojejunal junction — either by simple suturing or by the Murphy button. The technic of these procedures is exactly the same as in the case of uniting the fundus of the gall-bladder with the junction of the first and second portions of the duodenum, as far as the mechanical steps are concerned — and have been described and pictured upon pp. 529 and 531. Immediately following anastomosis between gall-bladder and jejunum, an anastomosis is formed between the two loops of the jejunum several inches below the first anastomosis.

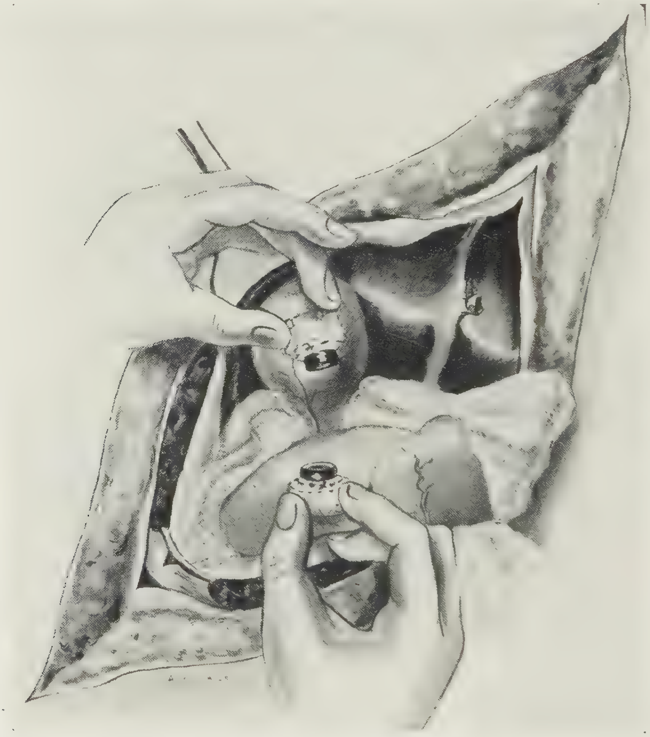


Fig. 3696.—Cholecystoduodenostomy by the Murphy Button.

Cholecystocolostomy.—Anastomosis of the fundus of the gall-bladder to the hepatic flexure of the colon is usually a comparatively easy procedure and capable of rapid accomplishment — and, in spite of the emptying of the gall into the large intestine, a very long distance from its normal site of entering the small intestine, no harmful results have appeared to follow. In spite of this, however, the colon should not be chosen for anastomosis if some part of the small intestine very near the stomach can be utilized.

Comments Upon the Anastomosis of the Gall-bladder with the Parts of the Gastro-intestinal Tract, in General.—Since it has been demonstrated that the duodenum can be mobilized by the Kocher method, this most desirable part of the intestinal tract for anastomosis is now even more available than formerly _ it being possible to make the anastomosis with even the second portion of the duodenum.

In the order of preference, as to the structure with which the gall-bladder may be united, come the duodenum, jejunum, colon, and stomach _ though some may place the stomach third and the colon last.

When the gall-bladder is incised, the patulousness of the cystic duct should be determined with a probe.

If the obstruction to the on-flow of bile for which the operation was performed is relieved, the internal fistula is apt to close of its own accord.

It is not necessary to select the tip of the fundus of the gall-bladder as the site for uniting with the duodenum _ its lateral aspect may be chosen.

One of the modifications of cholecysto-enterostomy sometimes performed is to divide the jejunum _ then unite the proximal end of the distal segment to the gall-bladder _ and finally, anastomose the distal end of the proximal segment into the distal segment at a lower level.

CHOLECYSTECTOMY

Description.—Excision of the gall-bladder _ after the ligation of its duct, and followed by the suturing up of its bed.

Unanimity as to the surgical technic involved in the removal of the gall-bladder has been very much more definitely reached than has unanimity of judgment as to the relative merits of cholecystostomy and cholecystectomy. It may be said that in America, at the present time, there is a tendency to entirely remove the gall-bladder whenever there is occasion to operate upon the biliary tract at all. While there is no hard-and-fast line to determine which cases shall be subjected to the former and which to the latter, it seems probable that many gall-bladders are sacrificed without full warranty _ and which, under incision and drainage, would remain useful organs. There is a human tendency to treat lightly an organ whose presence *seems* not to be imperatively necessary in the physical economy _ even though unfortunate errors have been made in the past in regard to the total removal of other structures *then considered* unnecessary. Abroad, the gall-bladder appears not to be so sweepingly removed as in our own country. Besides, the removal of the gall-bladder does not prevent, absolutely, the formation of gall-stones and infection _ they may subsequently occur in the common duct. Indeed, Robson questions whether the common duct does not subsequently dilate and become, practically, a gall-reservoir, a secondary gall-bladder _ as he and others have encountered in some cases. The writer agrees with him, emphatically, in his remark _ "And at the best, it is merely an expression of ignorance to say that the gall-bladder has no useful purpose to serve." Surgical knowledge, at most, is very limited, indeed, exceedingly limited, and greater modesty of judgment as to what is and what is not necessary _ to say nothing of the lessons taught in the past _ might serve both Patient and Surgeon more substantially than the total sacrifice of *any* structure _ without very good and incontestable reason for its loss.

Charles H. Mayo states: _ "The discussion as to whether cholecystectomy or cholecystostomy is the better procedure, has been kept up from the earliest days of gall-bladder surgery. We now find that there is use for each in its place – cholecystectomy, however, being chosen increasingly often as the operation of choice."

Robson writes in this connection: – "Many surgical advances, especially in recent years, have been carried out with more zeal than discretion, and in several well-known instances the bounds of good judgment have been far passed, though ultimately moderation has prevailed. I here beg to offer a protest against the indiscriminate removal of the gall-bladder in all cases in which an operation on the bile passages is called for."

Kocher's views have been expressed under Cholecystostomy, p. 508.

Moynihan makes the following comment: – "During the last eight years I have inclined more and more to the performance of cholecystectomy, and after some hesitation and some trepidation, which experience has removed, I am strongly disposed to advocate the frequent, though certainly not the invariable, adoption of this operation in preference to cholecystotomy (meaning, cholecystostomy, as used in these pages), in view of the character of the cases that submit themselves to surgical treatment. Its advantages are that the operation removes the chief source of the disease; that it thereby prevents, in great measure, a recurrence, either of stones or of the inflammation which betoken their presence; and that growths in the gall-bladder or adhesions around it are subsequently impossible." He adds, further, that he has wavered, from time to time, as to whether cholecystostomy or cholecystectomy were the better procedure – with the conviction that if patients came to Surgeons early in the course of involvement, before the walls of the gall-bladder were seriously involved, then the removal of the stones and the establishment of gall-bladder drainage would restore perfect function – but that, unhappily, a very large number of the cases came after the gall-bladder walls were so radically damaged, that the simpler operation often failed to secure lasting results – and had to be followed by the more radical step.

Indications for Cholecystectomy.—It may be first stated, comprehensively, that the chief indication for the removal of the gall-bladder, is the presence, fundamentally, of disease of its walls of such nature, and in such degree, as not likely to be permanently cured by drainage. The special indications have been given under many headings: –

1. Thickened, contracted, deformed, adherent gall-bladder, due to prolonged or repeated cholecystitis – constituting a badly diseased organ, of little or no value.
2. Empyema of the gall-bladder.
3. Phlegmonous, gangrenous, or membranous cholecystitis.
4. Perforation of the gall-bladder due to ulceration.
5. Injuries to the gall-bladder or cystic duct, due to rupture, stab, or gunshot.
6. Primary (localized) malignant or disabling benign tumors.
7. Calcareous degeneration.
8. Distention of the gall-bladder due to stricture of the cystic duct.
9. Distention of the gall-bladder due to stones impacted in the cystic duct – where, and provided it is considered that either perforation caused by the stone may lead to stricture – or where, if the calculus be removed, ulceration from the former presence of the stone might lead to stricture.
10. Distention of the gall-bladder due to kinking of the cystic duct – to adhesions – or to neighboring growth – are usually considered grounds for cholecystectomy.

11. Mucous fistula of the gall-bladder, resulting from stricture of the cystic duct, or from other form of obstruction of the cystic duct, including operations upon the cystic duct.

12. Biliary fistula, provided the common duct is free.

13. "Strawberry gall-bladder."

Contraindications to Cholecystectomy;—

1. Simple cholelithiasis, in a bladder whose walls have not been seriously damaged by that condition and by infection — and where no stricture or ulceration of the cystic duct is present.

2. Obstruction of the deeper bile-ducts (or any question thereof) — unless the cystic or common duct have been anastomosed with the intestine.

Methods of Excising the Gall-bladder:—

A. Partial Removal of the Gall-bladder;—
  (*a*) Excision of the fundus of the gall-bladder.
  (*b*) Excision of the mucosa of the gall-bladder.
B. Total Removal of the Gall-bladder;—
  (*a*) Excision of the gall-bladder from the fundus, inward.
  (*b*) Excision of the gall-bladder from the cystic duct, outward — (retrograde cholecystectomy).
  (*c*) Subserous excision of the gall-bladder.
  (*d*) Cholecystectomy, with common duct drainage.
  (*e*) Excision of the gall-bladder and adjacent part of the liver for cancer.

The features of each procedure, as well as some of the aspects under which it is adopted, will be given under each method. The indications for the carrying out of one technic in preference to another is largely a matter of personal judgment and experience. The partial operations have a very limited field of application.

The various methods of exposing the gall-bladder have already been dealt with, at length — and the selection of the one most appropriate to the particular case — or the method considered the most generally fitted to the exposure of the organ, is largely a matter of individual preference.

The partial excisions of the gall-bladder are atypical operations, and are very seldom performed. They will be merely alluded to here. Doyen has described the excision of the enlarged fundus of the gall-bladder — first crushing the tract of section with heavy clamp-forceps, and then dividing the structure in the crushed area, after which an absorbable ligature is tied circularly around the part, and the stump is then invaginated within the gall-bladder by Lembert sutures through the outer coats. It is conceivable that some modification of such a procedure might be applied to cases of injury of the fundus, too extensive for repair by suturing the wound — in which the injured part is excised, and the divided margins brought together, either in the way just mentioned — or by a marginal suture of fine catgut through all the coats, followed by a burying-in tier of interrupted or continuous Lembert suturing.

The Mayos have, in some difficult cases, excised the mucosa of the gall-bladder alone, without unfavorable results. This is accomplished by splitting the organ from the fundus to the cystic duct — after which the mucous membrane is stripped from its bed by blunt dissection and cut away — and the remaining coats sutured together by a double tier of sutures.

Excision of the Gall-bladder — from the Fundus, Inward.—Some Surgeons prefer to excise the gall-bladder from the fundus, toward the cystic duct, as a routine. Others use this technic only when the circumstances of the particular case make this procedure easier than to adopt the method in which the gall-bladder is first freed at its neck, and dissected toward the fundus _ as when the fundus is free and accessible, and the neck is more or less submerged by adhesions.

The gall-bladder is brought into the field, as well as possible, by upward traction upon and eversion of the anterior border of the liver. If very much distended, part of its contents is first removed by aspiration. An incision is then made through the serosa, into the connective-tissue plane _ along the line indicated in Fig. 3697 _ (after first clamping the needle-puncture, if one has been made). The incision is so laid out as to plan two small serous flaps to subsequently cover in, when sutured, the raw liver-bed left by the removal of the gall-bladder. The outline of these flaps will be determined largely by the size of the gall-bladder _ the flaps being larger and verging further on to the gall-bladder, when the gall-bladder is large, to cover a large bed _ and smaller under the reverse conditions. Having incised into the subserous areolar tissue the fundus of the gall-bladder is seized with curved clamp-forceps and drawn away from the liver, downward and inward, while the gall-bladder is freed by blunt dissection, aided, where necessary, by touches of the knife (Fig. 3698). As the dissection and freeing approach the neck of the gall-bladder, one is on the lookout for the cystic artery (a branch of the right

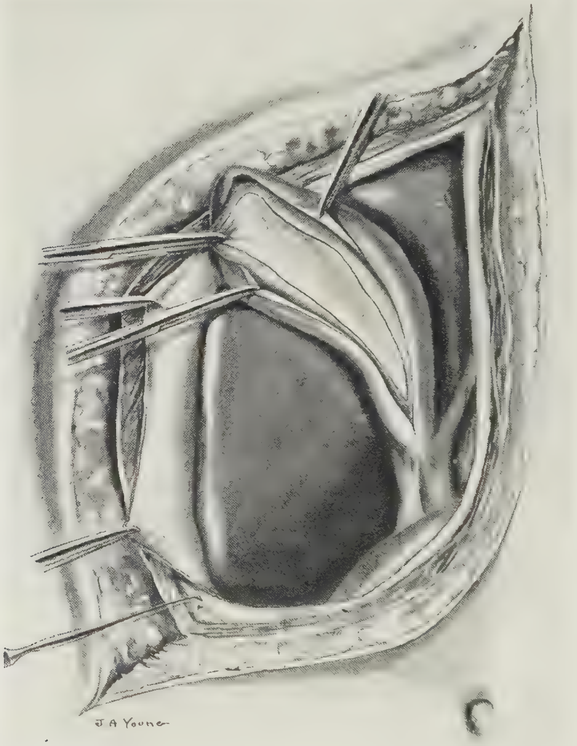


Fig. 3697.—Excision of the Gall-bladder _ from the Fundus, Inward. _ I; _ Incising the peritoneum over the free portion of the gall-bladder in such manner as to form two flaps of serosa, to be subsequently sutured over the raw bed of the excised bladder. The gall-bladder (previously partly aspirated, if very much distended) is about to be drawn downward and inward, during the dissection from its bed. In the lower part of the wound the tenth intercosto-abdominal nerve is seen, displaced downward, out of harm's way.

hepatic, coursing the side of the cystic duct), which should not be prematurely cut. The method of dealing with this vessel varies. It, together with the cystic duct, may be deliberately exposed by following them down in the dissection of the pedicle of the gall-bladder — which was the technic originally followed by Kehr. The cystic artery is tied before dividing into its two branches, as it courses along the cystic duct, toward the gall-bladder (Fig. 3699). When this method of freeing the structures of the cystic pedicle in detail is adopted, the cystic duct is also exposed in the dissection and dealt with. It is easy to at once tie and divide the cystic duct — but one thus foregoes the ability to probe the common duct through the divided cystic duct — so that it is better to clamp the cystic duct between the site at which it is intended to divide it and the gall-bladder — then make the division, catching the limited flow of bile from the hepatic duct upon previously placed gauze — after which the common duct can be probed — and, if patulous, the cystic duct is tied. Kehr formerly dissected back a cuff of serosa before dividing the cystic duct — but the duct is now generally divided transversely, through all of its coats. Figure 3700 represents the structures forming the pedicle of the gall-bladder, and those within the hepatoduodenal ligament — shown semidiagrammatically. As a rule, however, the structures of the cystic pedicle are somewhat differently dealt with — although the method just described is technical and

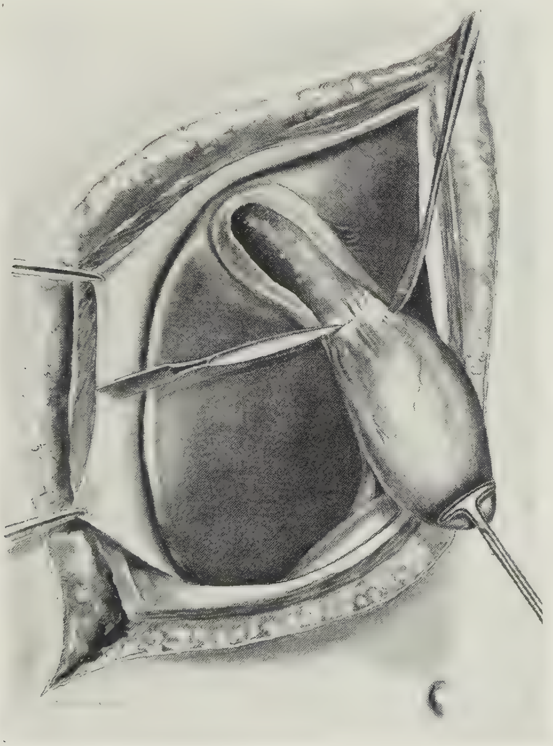


Fig. 3698.—The Same — II; — The gall-bladder is in the act of being freed from its bed — chiefly by blunt, but partly by sharp, dissection. The organ is put under gentle stretch, while being drawn downward and inward. If a distended bladder have been partly freed of its fluid by aspiration, the needle opening is controlled either by a clamp or purse-string ligature to prevent leakage.

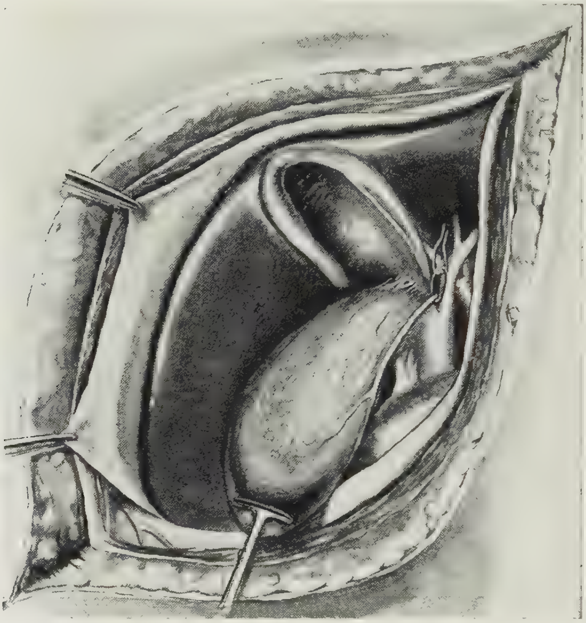


Fig. 3699.—The Same _ III; _ Continuing freeing structures of pedicle of gall-bladder in detail by dissection. The bladder has been freed until only held by its two chief structures, cystic duct and cystic artery _ and by bands of connective tissue and a strip of peritoneum. The cystic artery is exposed (while gall-bladder is drawn outward) _ by dissecting away from right hepatic artery, rather than toward it, so as not to injure that vessel _ and is tied (cystic artery) before dividing into its two branches.

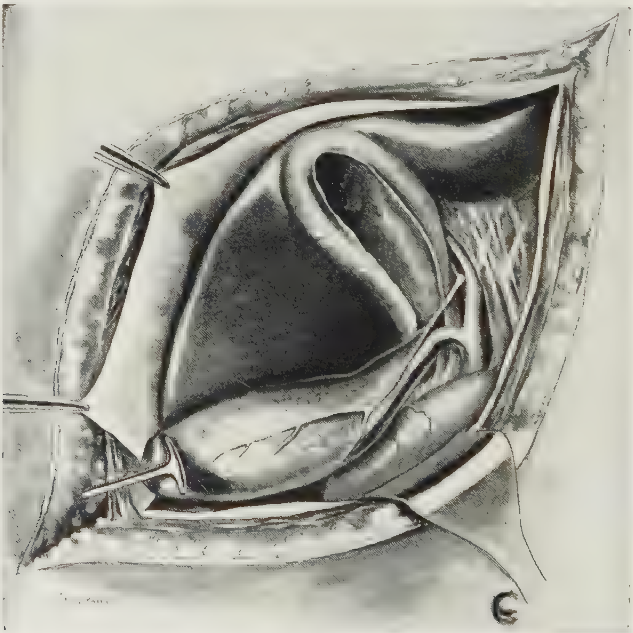


Fig. 3700.—The Same _ IV; _ Structures of cystic pedicle, cystic duct, and cystic artery are fully exposed, continuous with dislodged gall-bladder. The beginning of common duct, with its contributing cystic and hepatic ducts, is seen in dissected right margin of hepatoduodenal ligament _ and, behind anterior layer of hepatoduodenal ligament are seen hepatic artery, to left, and portal vein between and behind common duct and artery.

surgical. Kehr's later procedure, characterized by less detailed dissection, is as follows: _ the cystic duct is clamped nearer the gall-bladder (Fig. 3701) _ and then the cystic artery (whose position can be recognized by its pulsation) is clamped nearer the hepatic duct. The clamp controlling the cystic artery is made to seize only the cystic artery and its surrounding connective tissue, carefully avoiding the compression of the cystic duct (whose lumen must be left open for probing). The pedicle is then divided between the clamps, after which the cystic artery is isolated and tied. In this way one may probe the common duct through the divided cystic duct. If the common duct be free the cystic duct is ligated.

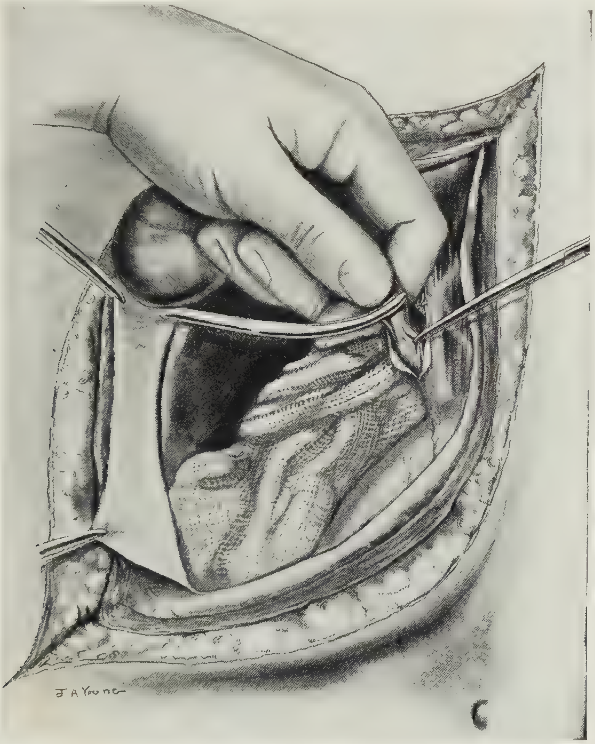


Fig. 3701.—The Same _ V; _ Controlling the structures of the pedicle of the gall-bladder prior to their division. In the process of dissecting the gall-bladder from its bed, the free (outer) border of the hepato-duodenal ligament has been opened. Kehr's method of dealing with the cystic pedicle consists, after well packing off the region with gauze, in placing one clamp over the entire cystic pedicle, near the gall-bladder (to control its flow) _ and then, near the hepatic duct, to seize with another clamp the connective tissue surrounding the cystic duct and including the cystic artery (to control hemorrhage) _ after which the pedicle is divided between the two clamps. The little leakage from the cystic duct is caught upon gauze _ as the lumen of the common duct is probed by way of the stump of the cystic duct. The cystic artery is tied _ and then the cystic duct is ligated (if the common duct be patulous).

Finally, the peritoneal flaps are sutured together over the raw bed left by the excision of the gall-bladder (Fig. 3702). Where no drainage of the biliary ducts is indicated, the ligated stump of the cystic duct is buried beneath the sutured-together peritoneal flaps which cover the former bed of the gall-bladder.

Excision of the Gall-bladder from the Neck Outward.—It has already been mentioned (at the beginning of the preceding operation) that it

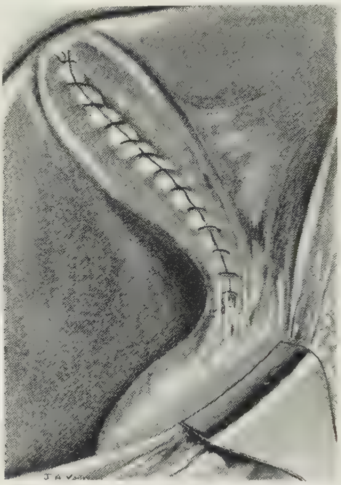


Fig 3702.—The Same – VI; – The peritoneal flaps (previously provided) have been sutured together over the bed of the excised gall-bladder – burying in the ligated stump of the cystic duct.

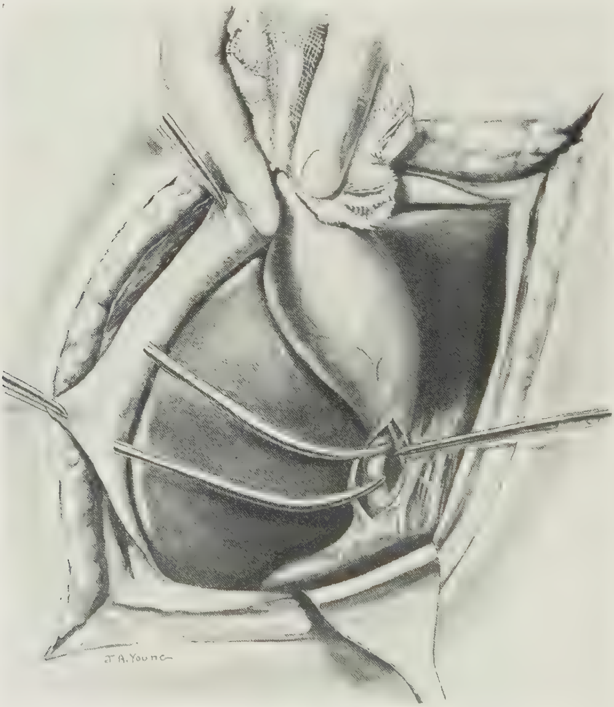


Fig. 3703.—Excision of the Gall-bladder from the Neck Outward – I; – By traction upon the fundus of the gall-bladder the bladder, cystic and common ducts have been rendered straighter and more accessible. The peritoneum has been incised over the cystic duct – and one clamp applied nearer the common duct, and the other nearer the bladder, prior to dividing the duct between them. A third clamp is upon the cystic artery and vein.

is largely a matter of personal choice, and the environmental circumstances of the individual case, as to whether the beginning of the excision of the gall-bladder be made from the fundus or from the neck. It would seem that the majority of Surgeons begin the dissection at the neck of the organ. Rather than have any fixed rule as to the place of beginning, it might be the better practice to begin the excision at that end of the organ least involved by pathologic conditions, especially adhesions _ and work toward the more involved region. In beginning at the neck the most difficult part of the operation is first finished _ which is the ligation of the pedicle, including the cystic artery, with a subsequent drier field.

Upon opening the abdomen by the elected method, an examination is made of the gall-bladder region _ and all adhesions which interfere with the field of operation, or with the manipulations, are cleared away as freely as possible _ after displacing the anterior margin of the liver first downward, below the costal arch, and then everting and rotating it, by means of a gauze-covered hand, as previously shown in Fig. 3680. Another way of digitally manipulating the parts, so as to straighten and make prominent both the gall-bladder and ducts, as well as to bring them nearer the front, is to cover the fingers with gauze and grasp the rather resistant gall-bladder between thumb and first finger, in the sulcus on each side, between bladder and liver. With the margins of the abdominal wound well retracted, and the field thoroughly packed off with gauze pads, the gall-bladder, from fundus to neck, and the cystic and common ducts, are drawn from their usual angle, into an approximately straight line, and rendered fairly accessible, if all interfering adhesions have been removed.

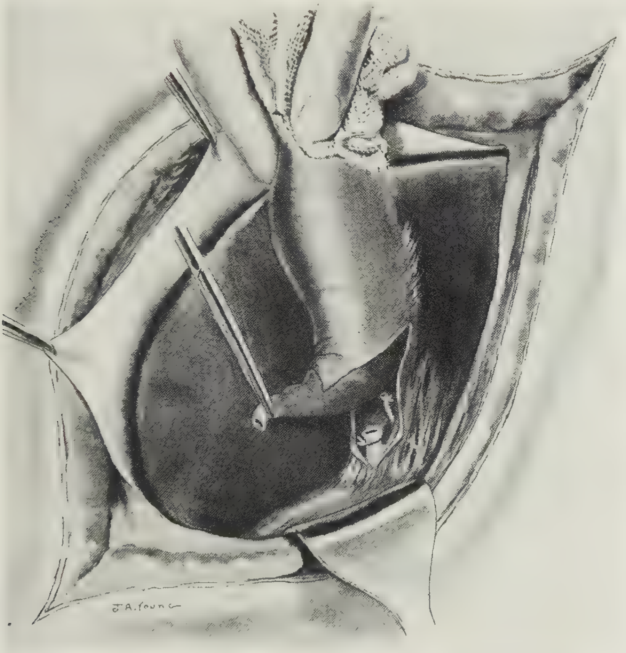


Fig. 3704 —The Same _ II; _ Dividing the pedicle of the gall-bladder.

When the parts are thus put upon the stretch, the biliary tract should be finally carefully palpated with the finger, to see that there are no stones in the hepatic or common ducts. The peritoneum is then incised over the cystic duct, exposing the cystic duct and its union with the hepatic duct to form the common duct. The cystic duct is then seized with a clamp within about 1.2 cm. (½ inch) of the common duct _ and with another, nearer the gall-bladder (as shown in Fig. 3703) _ and cut with scissors between them (Fig. 3704). The proximal end of the cystic duct is often sterilized with the cautery point and is then ligated with fine chromic catgut. The gall-bladder end of the cystic duct is kept from soiling the wound. Sometimes a peritoneal cuff is made, by a circular division around the cystic duct, and turned back, before the duct is divided and tied (as in Kehr's technic _ v. p. 548). The cystic artery and vein are then exposed, by dissection, somewhat to the inner aspect of the cystic duct, after retracting the tissue at the junction of the cystic and common ducts _ and are ligated and divided. While this individual exposure of the structures to be ligated is more surgical and is desirable, the cystic duct and artery are often seized at the same time, in the clasp of the same clamp, and ligated by carrying an aneurysm needle or Reverdin needle through the outer border of the hepatoduodenal ligament _ as shown in Fig. 3705. If there be any question as to the patulousness of the common duct, it should not be tied until a probe is passed through its cut end, and on into the common duct _ Fig. 3706 _ after making ample provision to protect the wound from soiling during the probing, as explained in the preceding operation. The opposite walls of the cystic duct should be seized with fine clamp-forceps and held apart during the passage of the probe. When this has been satisfactorily

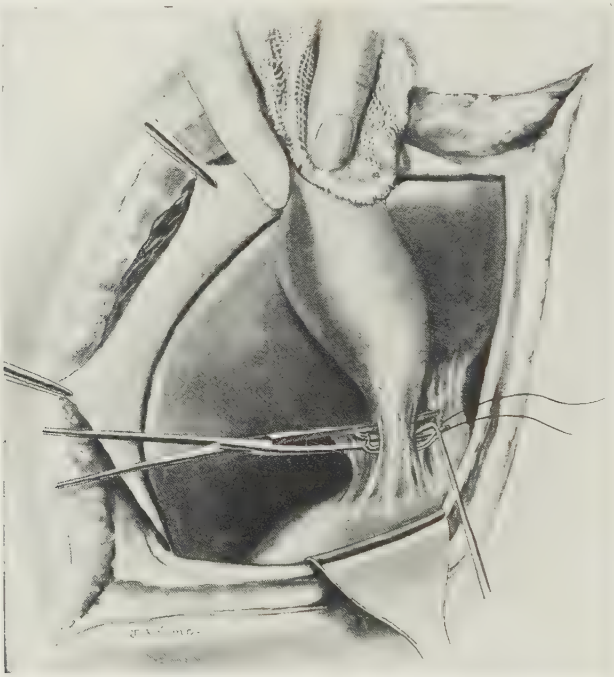


Fig. 3705.—The Same; _ Ligating the cystic duct and cystic vessels *en masse* _ after tunneling through the hepatoduodenal ligament immediately beneath them, with narrow, hemostatic forceps, and separating their blades for the passage of a ligature-armed aneurysm needle _ or, after tunneling a passage, the ligature may be drawn back by the forceps alone. Great care is to be exercised in this method of blunt dissection to avoid injuring the vena porta, or hepatic artery.

accomplished, the severed end is ligated, as seen in Fig. 3704. If there be question of infection of the hepatic ducts, or common duct, a rubber drainage-tube is tied into the cut end of the cystic duct. The tube is first anchored in the mouth of the cystic duct by a single fine catgut suture _ and then the margins of the cut duct are tightened around the tube by a previously placed purse-string ligature. At the end of about a week the tube usually comes away, after which time drainage continues for a time along the walled-off peritoneal tract.

The major part of the procedure having been completed, which are the details about the neck of the gall-bladder, cystic duct, and cystic vessels, the body of the gall-bladder is excised. This is accomplished by carrying two incisions through the overlying peritoneum, in such manner as to plan two flaps calculated to meet and fill the bed of the excised bladder. These flaps are dissected from off the sides of the gall-bladder _ and the bladder itself is removed from its bed by blunt dissection, and snips of curved Mayo scissors, in the connective-tissue plane. The appearance of the parts following the total excision of the gall-bladder are as suggested in Fig. 3706 _ where the steps of the operation are still in progress. The cystic duct stump is buried under the peritoneal flaps (unless drainage of it be established). Temporary drainage of the gall-bladder bed is advisable (Fig. 3710).

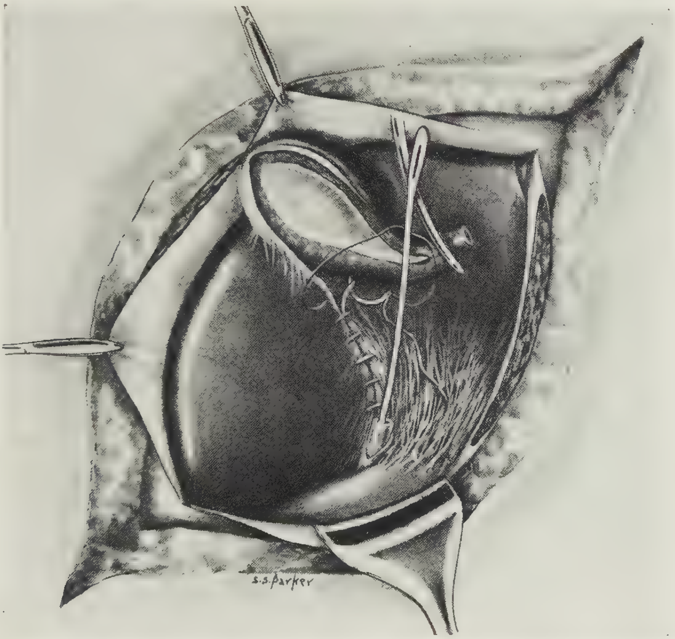


Fig. 3706.—The Same; _ The bed of the gall-bladder is being covered by the suturing together of the margins of the peritoneal coat of the organ, *pari-passu* with its dissection, from neck, outward. The patulousness of the common duct is being tested by means of a probe carried into the duodenum.

Subserous Excision of the Gall-bladder.—This method of excising the gall-bladder is sometimes employed _ especially in cases where the environment of the bladder is much involved in adhesions, particularly in the neighborhood of the cystic duct, making unusually difficult the exposure required for the ordinary methods of excision. The two methods of subserous excision generally used are Witzel's and Doyen's.

Witzel's Method of Subserous Excision of the Gall-bladder: The lower border of the liver is exposed and everted in the usual way. The fundus of the gall-bladder is seized with clamp-forceps, traction upon which further exposes and straightens the bladder and cystic duct. An incision is then made through the serosa, along the under surface of the bladder and duct (Fig. 3707). The two lips of the serosa are dissected back sufficiently to be caught by clamp-forceps, which henceforth serve as tractors — and the forceps which first grasped the fundus is then either entirely removed, or changed so as to grasp only the serosa. The incision is continued so as to split the serosa almost to the end of the fundus — and down well on to the beginning of the cystic duct. Working by blunt dissection in the connective-tissue space between the serosa and the fibrosa, one shells out the gall-bladder from its bed, which is formed upon its free surface by serosa, and, upon its attached surface by the liver. When the neck of the gall-bladder and the cystic duct are exposed, the cystic artery and vein are sought, lying above and to the inner side, and are ligated and divided . individually (Fig. 3708) — or *en masse* (Fig. 3709). As the freeing progresses, and it can be largely accomplished by the curved Mayo scissors and a blunt dissector, one can finally entirely surround the bladder with the finger — which will aid in traction upon the organ, and in the further exposure of the cystic duct — splitting the serosa over

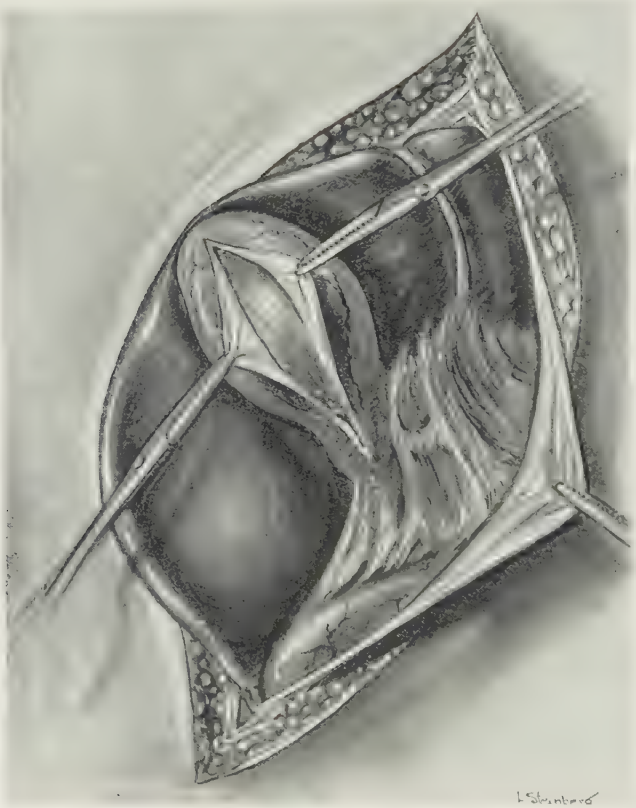


Fig. 3707.—Subserous Excision of the Gall-bladder — Witzel's Method — I; — Exposure of the gall-bladder and cystic duct — and incision through their serosa.

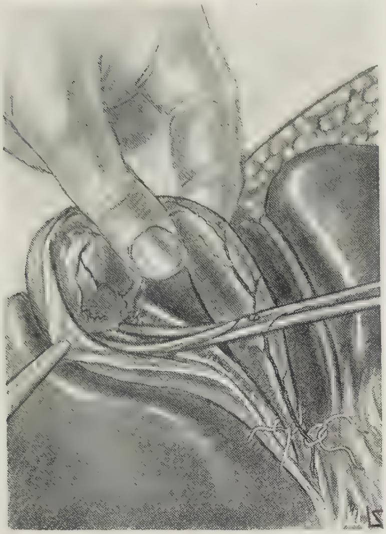


Fig. 3708.—The Same _ II; _ The gall-bladder has been shelled from its bed, largely by blunt dissection, in the connective-tissue plane between the serosa and fibrosa, in its free part, and between the fibrosa and the liver-bed, in its covered part. Ligatures have been separately placed upon the neck of the cystic duct and upon the cystic vessels. A clamp will close the cystic duct before the division is made

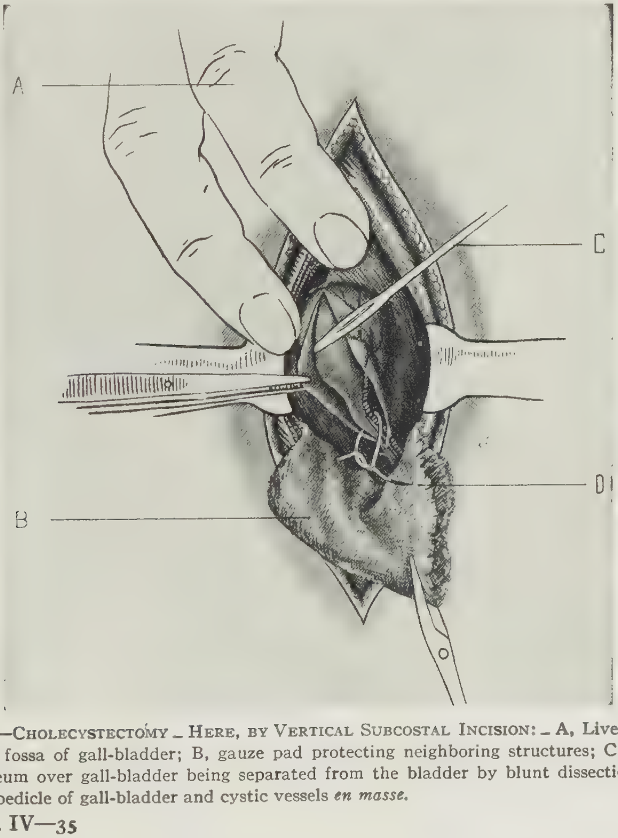


Fig. 3709.—Cholecystectomy _ Here, by Vertical Subcostal Incision: _ A, Liver displaced upward, exposing fossa of gall-bladder; B, gauze pad protecting neighboring structures; C, longitudinally incised peritoneum over gall-bladder being separated from the bladder by blunt dissection; D, ligature placed around pedicle of gall-bladder and cystic vessels *en masse.*

the duct further down, if necessary. When the gall-bladder has been entirely freed, and gauze pads have been placed to catch any outflow of bile, the cystic duct is clamped toward the bladder, and the end toward the common duct gently held by a second clamp, which grasps one wall, without occluding the lumen _ after which it is divided between them. The patulousness of the ducts is then determined, by probe and digitally _ and if this examination be satisfactory, the cystic duct is ligated, and then divided. In completing the operation, a rubber drainage-tube is carried outward, from the ligated cystic duct, in the gall-bladder bed _ and the margins of the serous flaps, separated in freeing the bladder, are now sutured together over the tube and over the raw surface of the liver _ as shown in Fig. 3710. The abdominal wound is closed down to the exit of the tubal drain. The drain is usually removed within forty-eight hours _ and is sometimes not employed. But as the raw surfaces are considerable, temporary drainage is probably better. Gauze drainage is sometimes used instead _ but its exit weakens the abdominal wound.

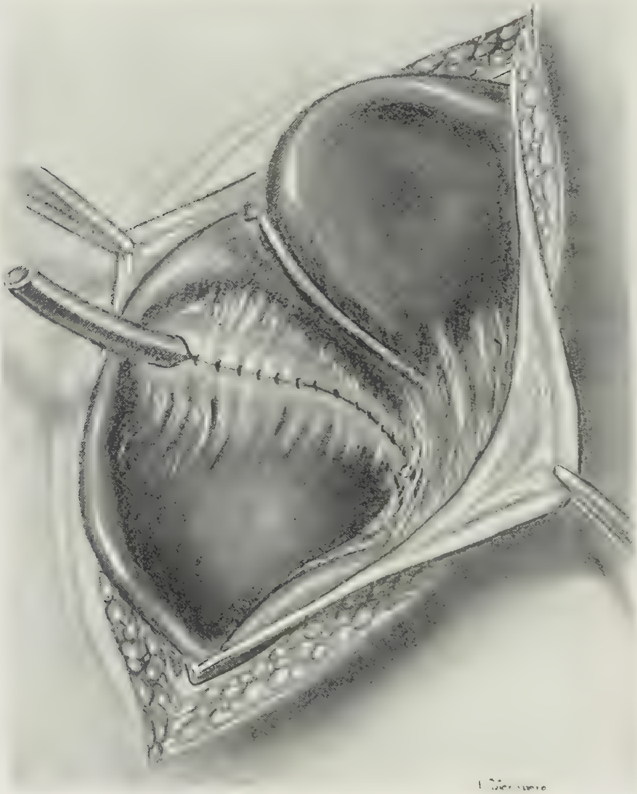
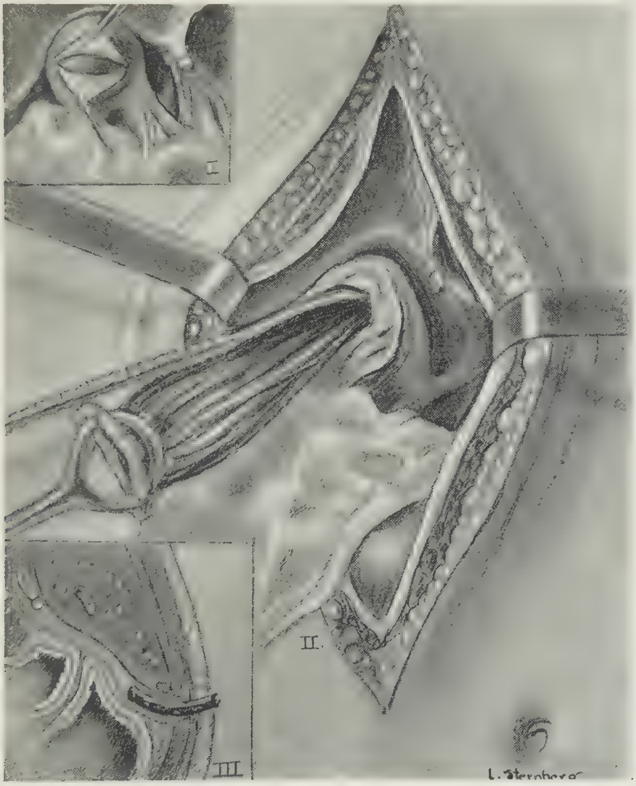


Fig. 3710.—The Same _ III; _ The margins of the separated serosal flaps have been sutured over the empty bed of the gall-bladder, and over the temporary rubber drain. The stump of the ligated cystic artery is seen through the serosa.

Doyen's Method of Subserous Excision of the Gall-bladder: This method of subperitoneal decortication, as Doyen terms the technic, is characterized by the enucleation of the gall-bladder from its serous covering, which is then marsupialized as an empty sac, whose cavity, as well as the cystic duct, ligated and divided within this serous sac, are temporarily drained. The technic is as follows: _ The abdomen is opened by an incision down the external border of the right rectus muscle. Having explored the biliary tract, brought the gall-bladder into the wound, and packed off the field with gauze, an incision is made through the serosa of the fundus, parallel with the margin of the liver _ after which the lips of this incision are separated by blunt dissection, and each serous flap seized with a clamp (Fig. 3711, I). As soon as the serous flaps are dissected back a little way the exposed fibrous coat of the fundus is seized with a ring-clamp and drawn upon, while the process of blunt dissection is continued _ until the serosa has been pushed back, like a glove-finger, from the rest of the gall-bladder and the beginning of the cystic duct (Fig. 3712, II). The gall-bladder and cystic duct are then each seized in the same way as described in Witzel's operation. The duct is then divided between the clamps and the gall-bladder removed _ after which if the ducts, as examined by probe and finger, are proved to be patulous, the stump of the cystic duct is ligated. The empty cuff of serosa is then drawn outward and anchored into the lower plane of the wound extraperitoneally. A drain is



Figs. 3711–3713.—Doyen's Method of Subserous Excision of the Gall-bladder: _ I, Transverse splitting of the serosa over the fundus of the gall-bladder _ the margin of each resulting serous flap being seized with a clamp; _ II, Freeing the fibrosa of the gall-bladder from the serosa by blunt dissection _ to and including the beginning of the cystic duct; _ III, Sectional view of the marsupiliated, empty, serous covering of the gall-bladder _ with a drain into it, passing from its anchored extremity in the abdominal wall out to the skin surface.

not carried down to the ligated cystic duct _ but a perforated glass tube is carried just beyond the thickness of the abdominal wall _ as shown in Fig. 3713, III.

Cholecystectomy with Drainage of the Common Duct.—This technic is especially employed by Kehr in those cases where an infected gall-bladder full of stones has been excised, and from the divided cystic duct thick, turbid gall flows. Drainage of the common duct, including the hepatic duct, is established by means of a T-shaped rubber tube, sutured within its lumen. In Fig. 3714 is represented the stage immediately following the excision of the gall-bladder in the ordinary manner. The region is well packed off with gauze _ the margins of the divided cystic duct is seized with two fine clamps, and so held as to hold the mouth of the severed mouth of the cystic duct open, while an ordinary uterine sound, probe, or grooved director is passed down the cystic duct into the common duct _ until its tip has passed close to the upper border of the duodenum under observation (its presence being followed as its

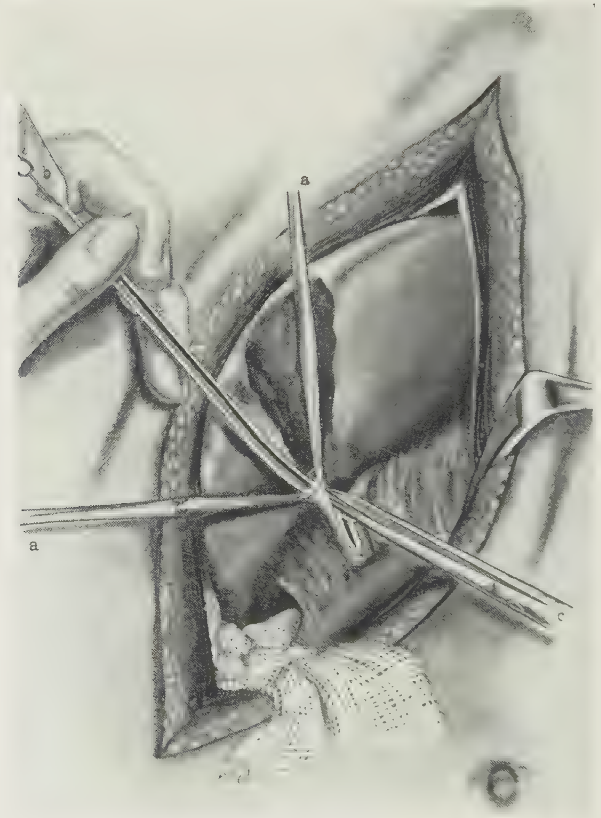


Fig. 3714.—Cholecystectomy, with Drainage of the Common Duct _ I; _ The gall-bladder has been excised. The mouth of the divided cystic duct is seized by two delicate clamps and held apart _ while a curved, grooved director is passed in from the transversely divided end of the duct _ and out through the axial incision which has been made in the common duct _ and, upon this, cutting upward with scissors or knife, the terminal end of the cystic duct is divided or split. (This especial manipulation, suggested by the Author, differs slightly from Kehr's technic, in which the incision of the cystic duct is made upon a sound.)

outline is observed through the ductus choledochus) _ and then completes the examination of the entire duct. Following the determination of the patulousness of the duct, the supraduodenal portion of the common duct is split, on its anterior aspect, on upward into and through the entire length of the remaining short piece of the cystic duct _ the incision being shown in the act of the making, in the picture just cited. The clamps then retract the two lips of the split cystic duct to either side _ exposing the opening of the hepatic duct, where it becomes continuous with the split portion of the common duct. That portion of the flap which is formed by splitting and spreading out the

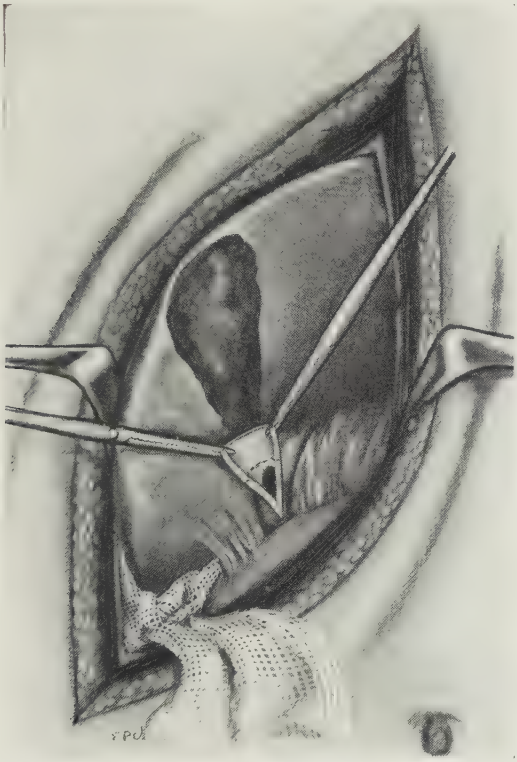


Fig. 3715.—The Same _ II; _ The stump of the cystic duct, which has been split by the incision extended upward from the common duct, is grasped by two clamps and held apart, flap-fashion, while the excision of it is planned as shown by the dotted line, so fashioning it that it may contribute its part toward the closure of the opening holding the drain, as seen in the next step. (It would seem that Kehr's method of cutting the duct opening, here shown, could be better adapted to the subsequent fitting.)

stump of the cystic duct is seized by two forceps and cut off, in the manner indicated by the dotted line _ Fig. 3715 _ so planned as to make provision for the next step. The forceps are again shifted, to take hold of each flap laterally and retract it _ while a T-shaped rubber drain is introduced _ the upper short arm passing into the hepatic duct, and the lower short arm into the common duct (Fig. 3716). The short arm of the T drain is here shown split (which is more easily withdrawn, subsequently). The first tier of closing sutures is of fine chromic catgut _ passes, in interrupted sutures, through the mucosa of the margins of the wound in the common duct, carefully avoiding engaging itself in the rubber drain. The drain is so disposed that its outer arm is pushed nearer the upper limit of the wound in the ductus choledochus. The manner of placing the sutures through the mucosa, and when tied, is as seen in Fig. 3717. The second tier of suturing, also of fine chromic catgut, are double-knotted, interrupted Lembert stitches through the outer coats only, and not including the margins of the wound _ as seen in the last figure. The tube is conducted out of the abdominal wound, which is sutured up to its point of exit. In twelve or fourteen days the T-drain is withdrawn _ and in drawing it through the sutured wound in the ductus choledochus the margins approximated by the two sutures immediately next the tube may be separated slightly, but tend to come together immediately after the tube has slipped through. By this time, too, the rubber tube, in its passage outward through the peritoneal cavity, from the common duct to the abdominal wound, has been surrounded by adhesions, constituting a safe drainage channel during the remaining time fluid continues to flow from the common duct.

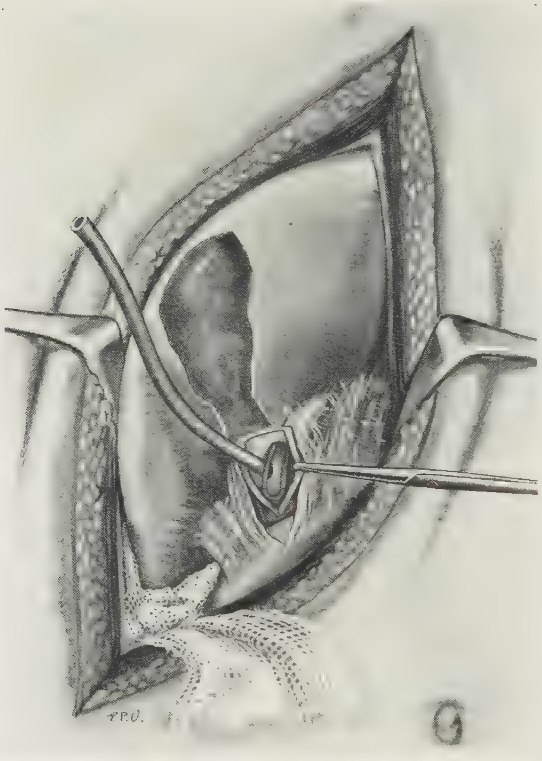


Fig. 3716.—The Same _ III; _ The margins of incision into the common duct are now drawn lateralward by two clamps _ while a split T-shaped rubber drain is so placed that its upper arm passes into the hepatic duct, and its lower into the common duct _ after which the long arm of the drain is pushed nearer the hepatic duct end of the wound _ preparatorily to suturing the opening into the duct around the tube.

Excision of the Gall-bladder and Adjacent Part of the Liver for Cancer.—Primary cancer of the gall-bladder which has limitedly involved adjacent portions of the liver, is sometimes subjected to excision of the gall-bladder itself, together with the neighboring portion of the liver involved. The procedure is, of course, one of considerable magnitude _ chiefly, as far as the operation itself is concerned, on account of hemorrhage. The general technic in excising parts of the liver, as well as the methods employed for the control of bleeding, have been considered under the Liver (v. pp. 482–485). The general method ordinarily adopted is to excise a wedge-shaped piece of the liver, whose center is the gall-bladder, and whose sides come together in the vicinity of the cystic duct — the section passing entirely through the thickness of the liver. Kehr describes such a technic, which he has several times applied. An unusually free exposure of the liver is required. The cystic artery and vein are usually first exposed by dissection, at the apex of the wedge, in their course to the inner side of the cystic duct, and ligated.

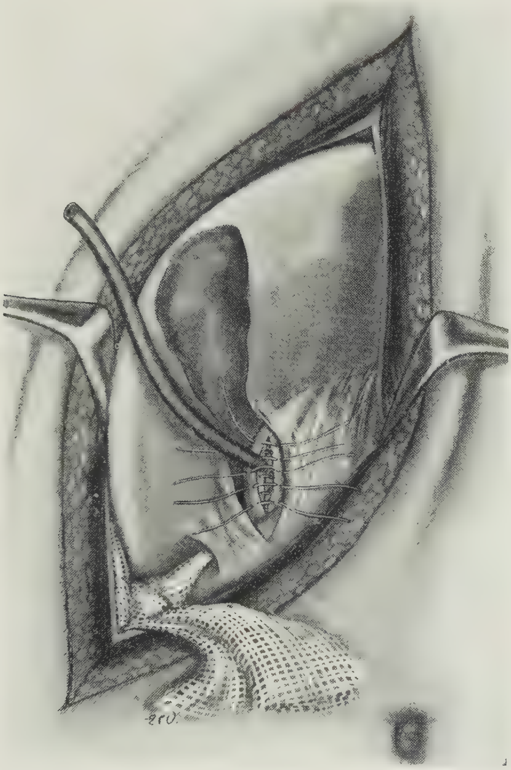


Fig. 3717.—The Same — IV; — The first tier of interrupted marginal sutures has been carried through the mucosa of the common duct and tied, — and the second tier of interrupted, non-marginal, non-penetrating seromuscular Lembert sutures are in position, ready to be tied. The course of the drain is indicated. (The mouth of the cystic duct, into the common duct, has been here so sectioned as to better adapt it to the implanted drain.)

The lines of the excision are shown in Fig. 3718. Outlying the lines of section, two lines of interlocking sutures may be first placed and firmly tied for the purpose of controlling hemorrhage. These interlocking sutures should be strong, stout chromic catgut, carried entirely through the liver substance by means of a special blunt liver needle (such as the Koutnezoff needle, with its eye at the tip — or a dull-ended Reverdin needle). Each pair of adjacent sutures interlock — and are sufficiently tightened, in the tying, to compress the intervening hepatic vessels, without cutting the substance of the liver. The wedge-shaped piece of liver, including the gall-bladder, is then excised by knife — immediately following which the cut vessels found upon the two surfaces are systematically drawn out with forceps and tied with catgut. In Fig. 3719 the ordinary method of suturing is shown. To this it would seem well to add the method of approximating these hemostased sides by sutures placed as shown, ready to be tied. In concluding the operation a gauze pack is placed along the upper suture line, and another along the lower suture line, and both are conducted out of the abdominal wound, as temporary drains — the abdominal wound being closed up to the exit of these drains.

Comments Upon Cholecystectomy, in General.—Wherever the gall-bladder, hepatic, or common ducts have been infected, temporary drainage is indicated — and some Surgeons temporarily drain in practically all cases independently of infection.

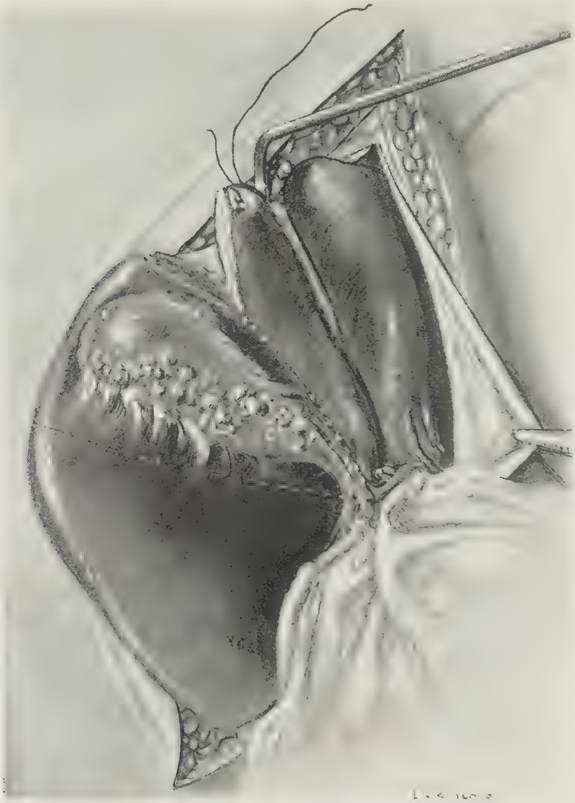


Fig. 3718.—Excision of the Gall-bladder and Adjacent Part of the Liver for Cancer — I; — The lines of the proposed wedge-shaped excision are dotted — the cystic vessels have been exposed in the hepatoduodenal ligament — and the cuneiform excision has been begun. Preliminarily to making the excision, the area to be excised is usually surrounded by some one of the forms of hemostatic suture-methods described and pictured under Operations Upon the Liver — in addition to which the main vessels may be ligated upon the cut surfaces, as encountered.

To prevent visceral adhesions Robson brings the right border of the omentum upward and disposes it between the drainage-tube, or gauze, and the viscera. In order to allow the larger abdominal wound to close readily and strongly he advises bringing the drainage out through a separate stab-wound, outside of the abdominal incision.

In those cases, following cholecystectomy, where it is uncertain as to whether the common duct is patent, the cystic duct can be cut long, and its distal end anastomosed with the duodenum.

Persistent biliary fistula between the gall-bladder and the skin, which sometimes follows cholecystostomy is, of course, not risked in performing cholecystectomy. To counteract this, however, cholecystectomy is a much more difficult operation than cholecystostomy in average cases.

In problems of the gall-bladder it must be remembered that the value of the gall-bladder is largely dependent upon the functional value of the ducts which drain it.

In this same connection, however, it is to be remembered that sometimes a duct which, at the time of the operation, appeared obstructed, subsequently, after drainage by external fistula has been established, will subsequently be shown to transmit bile.

When the gall-bladder walls are very thick and are bound down by dense adhesions, separation from the liver may be both difficult and dangerous _ because of tearing the liver and hemorrhage. It may also be difficult to ligate the cystic vessels, and the ligatures may not hold.

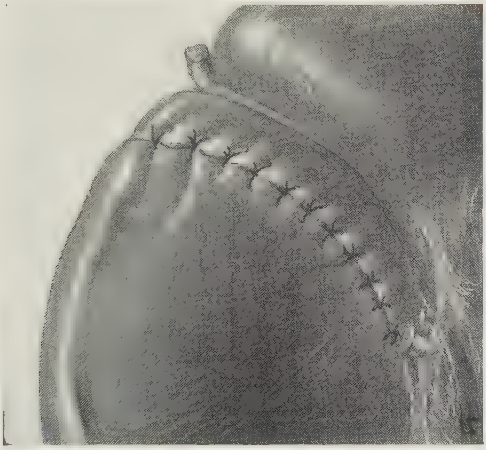


Fig. 3719.—The Same _ II; _ The gall-bladder and neighboring portion of the liver have been excised _ and the vessels upon the surfaces have been ligated. The surfaces, whose bleeding has been doubly controlled by the preliminary hemostatic sutures, and the subsequent ligation of the cut vessels, may be brought together by an upper and lower layer of stout catgut sutures.

The subserous excision of the gall-bladder _ which Kocher affirms is practised by most Surgeons _ can only be easily carried out, he states, when the subperitoneal tissues are loose and there is but little alteration in the walls of the gall-bladder.

When it is undertaken to remove the gall-bladder from its neck outward, if the cystic duct cannot be satisfactorily exposed, it is better to reverse the proceeding, and excise the gall-bladder from the fundus, inward _ thus stripping up the gall-bladder and exposing the cystic duct from that end.

Drainage of the hepatic duct is indicated when, following cholecystectomy, infection is found to have extended up the hepatic ducts into the liver _ otherwise drainage from the stump of the gall-bladder.

If it be necessary to drain the hepatic duct, the rubber drain is passed through the common duct, through the stump of the cystic duct (split, if necessary), and is directed up into the hepatic duct.

It is sometimes difficult to determine the patency of the ducts. They are usually tested by palpation – by probing, and by injecting fluid through the cystic duct (if the gall-bladder be open).

Two facts are to be remembered in sacrificing the gall-bladder: – first, that the patient is deprived of the organ, in case it might be indicated to use it in the future, in a cholecystenterostomy, – and, second, that if, following the removal of the gall-bladder, it be necessary to secondarily operate for calculi of the biliary tract, the conditions are less favorable.

Kocher states that external drainage is only necessary, imperatively, when severe suppurative or phlegmonous cholecystitis exists.

Stones in the biliary passages have been overlooked by the best operators in this field of work – and the hepatic and common ducts have been cut – against both of which the Surgeon should be on his guard.

In probing the ducts, one sound should be used for probing the common – and another for probing the hepatic duct, not to transfer infection.

When it is indicated to drain the hepatic duct, a rubber drain (with terminal, but no lateral opening) is carried through the stump of the cystic duct, up to the junction of the right and left hepatic ducts – after which it is slightly withdrawn, and then anchored with a catgut stitch to the stump of the cysticus.

OPERATIVE TREATMENT OF BILIARY FISTULÆ

Description.—A biliary fistula is a fistulous channel, connected with the biliary tract, which is discharging, or has discharged, bile. Two varieties occur. External biliary fistulæ empty upon the surface of the body. They occur most frequently postoperatively, following cholecystostomy, especially when some impediment to the normal flow of bile still continues. Some are spontaneous pathologic manifestations – as when an infected gall-bladder forms adhesions with some portion of the abdominal wall, and empites through the parietes. Internal biliary fistulæ are formed by the communication, by abnormal channel, of some part of the biliary tract, with some internal organ. They are generally the result of inflammatory, infective, obstructive, or malignant involvement – resulting, first, in the union of either the gall-bladder, or bile-ducts with some hollow viscus, followed, then, by the tunneling of the opposite walls bound by adhesions.

Operative Treatment of External Biliary Fistulæ.—External biliary fistulæ are sometimes called *complete*, when they discharge bile (and, often, calculi), as they usually do when pathologic – and *incomplete*, when they discharge mucus, as they often do at some stage of the postoperative history. Many fistulæ, however, may, at various times, discharge stones, pus, bile, and mucus, in varying proportions – hence the differentiations just given are only relative guides.

(*a*) Operative Treatment of Postoperative External Biliary Fistulæ: The continuation of bile-discharge usually indicates a continuing obstruction in the common duct. The amount of bile lost daily may run from a few to 1000 c.c. (1 quart) – and may continue from a few weeks to many months. It is usually considered unwise to operate in these cases as long as the escaping bile shows infection, if the conditions of the individual case admit of choice. Minor measures should be first tried out, realizing that even obstructing calculi are sometimes spontaneously thrown off, followed by spontaneous closure of the fistula. Irrigations with such fluids as olive oil, with a mixture of turpentine and ether, or with a 5 per cent. solution of animal soap, have been successfully made – by means of a catheter carried down the fistula. If time, and such means as mentioned, do not accomplish the object, one should proceed to dissect out the fistulous tract down to its origin, and remove the cause of its continuance, or, if that be impossible, make provision for the diversion of the bile into the intestinal tract. If a removable condition of obstruction in the common duct be discovered, this should be overcome – such as the pushing of a gall-stone into the intestine; the extraction of a gall-stone, with suturing or drainage of the common duct; the removal of a neighboring cause of compression; the dilatation, or plastic enlargement of a strictured common duct, and the like. If one be assured of the satisfactory re-establishment of the bile-flow through the common duct, the gall-bladder, if not markedly diseased (which it probably is), may be left after closure of the fistulous opening by plastic operation – but its total removal is probably a wiser procedure. If the obstruction to the common duct be found unremovable, and if, fortunately, the gall-bladder have not been already removed, and be available, cholecystenterostomy (preferably cholecystoduodenostomy) is the operation of choice – the bile being thereby conducted directly into the intestine. If the gall-bladder have already been removed, or should it have to be removed at the time of this secondary operation – and the common duct obstruction be irremovable – then some type of union must be made, either between the common duct above the obstruction, and the intestinal tract, or between the hepatic ducts and the intestine. All the precautions of an intra-abdominal operation must be observed.

(*b*) Operative Treatment of Postoperative External Mucous Fistulæ: The continuation of a mucous discharge from a gall-bladder still *in situ* ordinarily means that the cystic duct is impervious (from stone, tissue change, or other cause) – that is, does not transmit bile to the bladder – and that, therefroe, the gall-bladder is of no functional value. The amount of discharge, and the inconvenience, are generally much less than in the postoperative external biliary fistulæ – as long as the external opening remains patulous, and no accumulation occurs. The radical treatment of the case consists in dissecting the fistulous tract to its proximal end, at the gall-bladder, through the peritoneal cavity. The gall-bladder is then generally removed – provided the common duct be patent. Otherwise, cholecystenterostomy may be performed. If the gall-bladder have been removed, postoperative external mucous fistula from the stump of the cystic duct is rare.

Operative Treatment of Internal Biliary Fistulæ.—These fistulæ are usually pathologic, and are generally formed by the union of the gall-bladder, or biliary ducts, with other viscera, through the medium, first, of adhesions between them, and, then, the sloughing of the intervening walls, or barrier. Direct fistulæ are those in which the biliary tract communicates directly with the viscus into which the fistula opens. Indirect fistulæ are those in which this communication is indirectly brought about through the bed, or route of some abscess cavity. The range of internal biliary fistulæ is almost incredible – communications having been encountered between the gall-bladder, or ducts, and the stomach, all parts of the intestinal tract, liver, pancreas, urinary tract, pleuropulmonary tract, mediastinopericardial tract, the female genital organs, and even between different parts of the biliary tract itself. It will, therefore, be seen that the required details of surgical manipulations may be of the most diverse nature – differing, in detail, according to the structures involved, and the nature of the involvement. In the majority of instances internal fistula tend to self-healing after spontaneous drainage is accomplished – in those cases where the original cause of the fistula ceases to act. But even in these cases the consequences, in the form of crippling adhesions, is usually great.

It is impossible to plan in advance the details of operations for the radical cure of persisting internal fistulæ – or for the improvement of conditions caused by adhesions. The general aim, in persisting fistulæ, is to sever the fistulous tract and to close, by some plastic method of procedure, the opening into the viscus, or structure at each end _ dissecting out the fistulous tract, if it has any length, and its excision is indicated and can be accomplished, or leaving it. If the normal course of the biliary circulation can be re-established, this is done _ otherwise, some method of short-circuiting the bile-flow is worked out. Sometimes both plastic repair of the fistulous mouths and changed circuiting have to be carried out. Where the gall-bladder or cystic duct is irreparably involved, the gall-bladder is usually excised. Where the common and hepatic ducts are involved, drainage of these may be indicated. Adhesions are dealt with in the usual manner.

Comments, in General.—Biliary fistulæ are most usually caused by the following conditions: _ non-healing of a cholecystostomy wound _ non-patency, kinking, or gall-stone obstruction of the cystic duct _ obstruction of the common duct by gall-stones, outside pressure, or by adhesions.

Mucous fistulæ cause but little irritation of the skin, while biliary fistulæ usually cause marked excoriation.

CHOLECYSTOLITHOTRITY

Description.—Consists in the exposure of the gall-bladder and crushing of the calculi from the outside, as they lie within the gall-bladder _ by means of the fingers or special forceps with protected blades _ and manipulating the fragments on into the cystic duct. The operation is sometimes applicable in cases of soft and friable stones. Fragments of hard stones are apt to wound the gall-bladder. Small stones may sometimes be pushed or worked on out of the gall-bladder into the cystic and common duct without being broken.

The steps of the operation are the same as those for cholecystotomy up to the point of exposing the gall-bladder _ after which it is a process of palpation and manipulation with the fingers, or special protected forceps.

GALL-STONES OF THE BILIARY PASSAGES

Frequency of Occurrence.—Calculi of either the gall-bladder or of the bile-ducts are seldom met in the young _ but are found frequently after middle age _ and are said to be present in one person out of every six after sixty years of age (and more frequently in women than in men). In a very large proportion of cases, probably the great majority, gall-stones have, up to the present time, given rise to no distinctively recognizable phenomena, or, as a rule, to any symptoms of discomfort recognizable by the patients _ and have been accidentally, or incidentally, discovered in the making of *post-mortems*. In spite of these facts, however, gall-stones in bladder or ducts constitute the chief cause for operation upon the biliary tract. Cholecystitis is often a correlated condition.

Varieties of Biliary Calculi.—Naunyn's classification of gall-stones, quoted by Moynihan, is as follows: _ (*A*) Pure cholesterin stones _ (*B*) Laminated cholesterin stones _ (*C*) Ordinary gall-bladder stones, without visible crystalline structure _ (*D*) Mixed bilirubin stones _ (*E*) Pure bilirubin-calcium calculi _ (*F*) Rarer forms of stones, consisting of: _ (*a*) Amorphous stones; (*b*) Chalk stones; (*c*) Concretions around foreign bodies; (*d*) Casts of the biliary passages.

Sites of Calculi of the Biliary Passages.—Gall-stones may occur in any part of the biliary tract _ right and left bile-ducts _ hepatic duct _ fundus of the gall-bladder _ neck of the gall-bladder _ in the continuity of the cystic duct _ at the opening of the cystic duct _ in the supraduodenal portion of the common duct — in the retroduodenal portion of the common duct — in the duodenal papilla of the common duct. These are shown graphically in Fig. 3720.

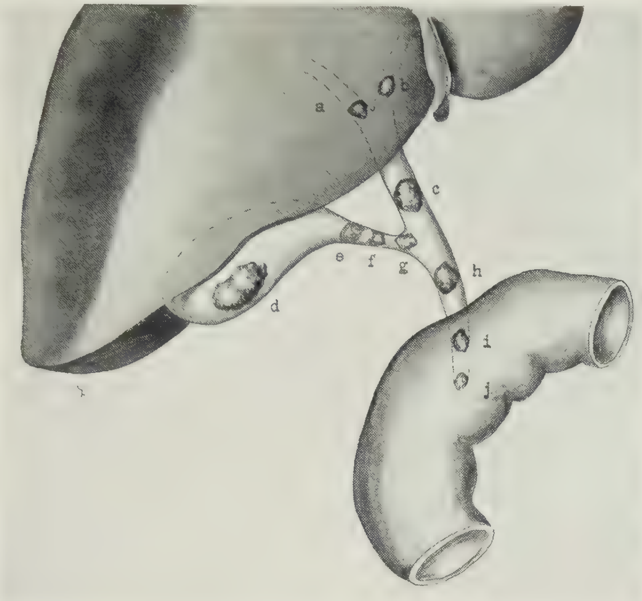


Fig. 3720.—SITES OF CALCULI IN THE BILIARY PASSAGES: — **a,** Stone in the right bile-duct; — **b,** in the left bile-duct; — **c,** in the hepatic duct; — **d,** in the fundus of the gall-bladder; — **e,** in the neck of the gall-bladder; — **f,** in the continuity of the cystic duct; — **g,** at the opening of the cystic duct; — **h,** in the supraduodenal portion of the common duct; — **i,** in the retroduodenal portion of the common duct; — **j,** in the duodenal papilla of the common duct.

EXTERNAL HEPATOCHOLANGIOSTOMY (EXTRA-ABDOMINAL DRAINAGE OF THE BILE-DUCTS)

Description.—It is known in cases of obstruction to the normal flow of bile, that the biliary canaliculi and ducts sometimes become so dilated as to be recognizable through the surface of the liver — and may even rupture through the liver substance. It is indicated to relieve the retention resulting from cholangitis and hypertrophic cirrhosis, and before rupture may cause pus formation in both peritoneum and in the liver substance. In those cases where the cause of the obstruction cannot be removed at all, or at the time, it is indicated to at least operate for the relief of the symptoms of the condition (as unsatisfactory as this always is), before a bad condition becomes worse. This is accomplished either through external drainage of the bile-ducts through the abdominal wall — or through internal drainage of the bile-ducts into some part of the gastro-intestinal tract (cholangiogastrostomy or cholangioduodenostomy). External drainage is generally more readily and more safely accomplished mechanically. Internal drainage is more difficult, surgically, and has a greater fatality, but is more satisfactory when accomplished. Following operation the cause of obstruction sometimes disappears spontaneously — or operation may be subsequently undertaken, for both the removal or betterment of the cause of the original obstruction, as well as for the repair of the fistula resulting from the external cholangiostomy.

Operation.—The site of greatest liver tenderness or bulge is usually selected, and the abdominal wall incised over this. If, by good fortune, adhesions be found between parietal peritoneum and liver, the procedure is much simplified _ incision being made directly into the substance of the liver, through the area of protecting adhesions _ and drainage established through the abdominal wall. If no adhesions be present, the liver surface is examined for the site of maximum involvement _ after which the capsule of the liver is sutured to the parietal peritoneum and subserous tissue in such a way as to surround a circular or oval area _ and in the center of this area an incision is made directly into the liver, and a drain through the abdominal wall established. Blood, pus, bile, and even stone and liver tissue may escape through this incision _ and provision must be made against soiling of the peritoneum. If the bleeding be marked, gauze packing is indicated _ the outward end of which serving as part of the drain. If a rupture have already occurred at the site, whatever soiling of the peritoneum may have taken place will have to be cleansed. The seat of rupture is then enlarged _ after which double drainage is established _ a rubber drain from the liver substance, and a drain of the local, or general peritoneum, dependent upon the amount of damage. The abdominal wall is closed up to the exit of the drain.

INTERNAL HEPATOCHOLANGIOSTOMY BY HEPATOCHOLANGIOGASTROSTOMY (INTRA-ABDOMINAL DRAINAGE OF THE BILE-DUCTS INTO THE STOMACH)

Description.—Drainage of the bile-ducts has been mentioned under External Hepatocholangiostomy, p. 557. Two forms of internal hepatocholangiostomy are practised _ hepatocholangiogastrostomy and hepatocholangioduodenostomy _ the latter being preferable. As in the external abdominal drainage of the bile-ducts, their internal drainage is resorted to where unremovable obstruction exists to the normal flow of bile, and where it is necessary to relieve the resulting tension and its possible consequences. This technic may find its application in such conditions as marked disease of the gall-bladder, requiring its excision, associated with a destructive and inoperable degree of stricture, or obstruction of the ductus hepaticus, requiring its sacrifice, especially when associated with a degenerated, cirrhotic liver.

Description.—The under surface of the left lobe of the liver, and preferably its border, is chosen, where possible. An opening parallel with its border is here made, about 3 cm. ($1\frac{3}{16}$ inches) long, and of fair depth _ either by means of a Paquelin cautery blade or by elliptic excision with a knife. It is especially favorable for drainage, if one happens to sever one or more large bile-ducts, in dividing the liver substance. A corresponding incision is made through the wall of the pyloric end of the stomach, parallel with and 2 to 3 cm. ($1\frac{13}{16}$–$1\frac{3}{16}$ inches) from the greater curvature _ and beginning about the same distance from the pylorus (marked by the pyloric vein). The openings in the liver and in the stomach are united, marginally, by two tiers of interrupted suturing _ an outer row, through the fibrous capsule of the liver, and the superficial subcapsular tissue (at a short distance outside of the opening), on the one hand, and through the serous and muscular coats of the stomach, on the other _ and an inner, marginal row, passing through the free border of the liver wound, including capsule and superficial tissue, on the one hand, and through all of the coats of the free border of the stomach wound, on the other. The technic of the procedure is seen in Fig. 3721.

In such an operation as this the gall-bladder is often first excised on

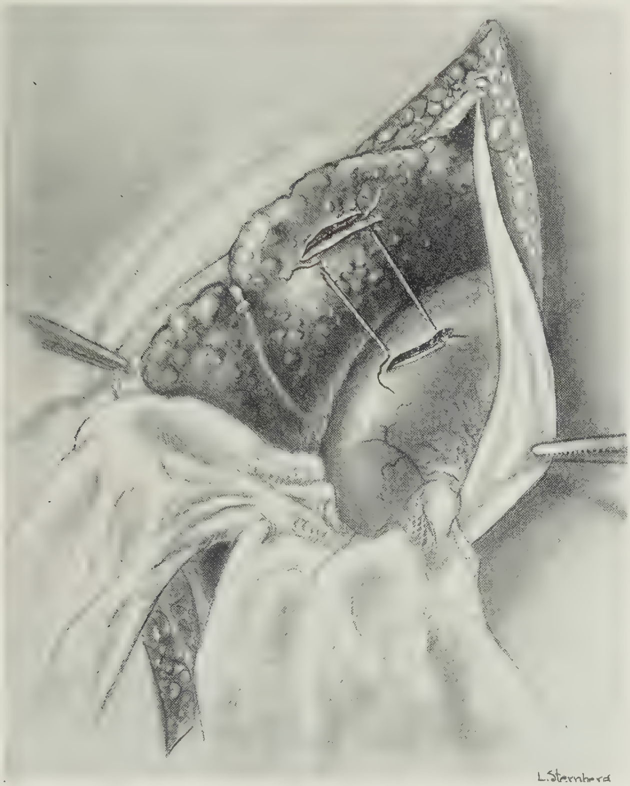


Fig. 3721.—HEPATOCHOLANGIOGASTROSTOMY; — The under surface of the left lobe of the liver is being anastomosed with the pyloric end of the stomach by means of openings made in both viscera. The method of introducing the uniting marginal and paramarginal sutures is shown by a suture of each set. The diseased gall-bladder has been excised. (For details see text.) (Modified from Kehr.)

opening the abdomen, and the partially or completely impervious hepatic or common duct may have been subjected to some additional operation.

Temporary drainage in so extensive an undertaking is instituted.

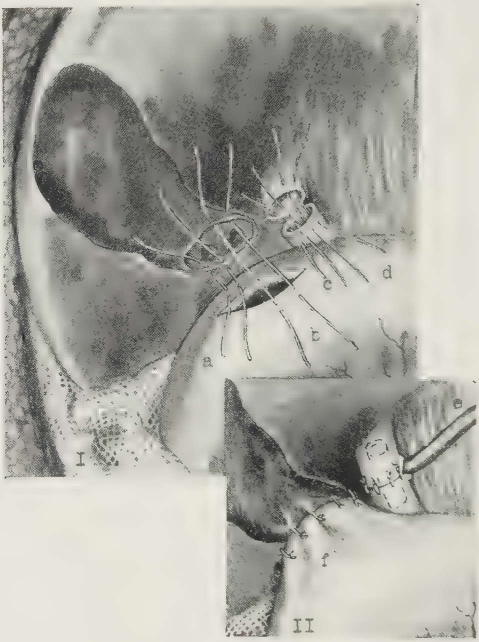
INTERNAL HEPATOCHOLANGIOSTOMY BY HEPATOCHOLANGIODUODENOSTOMY WITH OR WITHOUT EXCISION OF THE GALL-BLADDER, AND PARTIAL EXCISION OF THE DUCTUS HEPATOCHOLEDOCHUS (INTRA-ABDOMINAL DRAINAGE OF THE BILE-DUCTS INTO THE DUODENUM)

KEHR'S TECHNIC

Description.—The drainage of the bile-ducts is here made, as indicated by the title, into the duodenum — and is the operation of choice, as between the stomach and intestines. The operation has been performed in cases of permanent obstructive jaundice in which the obstruction to the normal on-flow of bile cannot be relieved by other means. Kehr has applied the technic in cases of extensive involvement of the biliary tract by new growths, extensive cicatricial adhesions, and the like — sometimes involving the sacrifice of the gall-bladder and part of the ducts, with the repair of the portion of the ducts left, in case that some degree of patulousness and drainage persists. The steps covering this maximum degree of involvement will be here described.

Operation.—The gall-bladder and cystic duct are re-excised — as well as a limited portion of the junction of the ductus hepaticus and ductus choledochus, where the cystic duct joins them. In the raw bed left upon the under surface of the liver by the excision of the gall-bladder the mouths of some enlarged bile-ducts are apt to be encountered, and if, fortunately, several open in close proximity, in an accessible site, this region is taken for anastomosis with the duodenum, that the bile-drainage into the intestine may be as free as possible.

The lower dvided end of the ductus hepaticus, above, is anastomosed with the upper divided end of the ductus choledochus, below — a T rubber-drain being temporarily inserted as the ends are being brought together. The union is made by a marginal tier of catgut sutures passing through all the coats of the divided ends of the ducts — followed by a reinforcing tier of silk or Pagenstecher sutures through the outer coats, approximating serosæ — as shown in Figs. 3722 and 3723. If the posterior aspect of the divided ends are difficult to manipulate, these absorbable sutures may be so placed that the knots fall within the lumen — while the rest of the marginal sutures will be tied on the outer side.



Figs. 3722 and 3723.—HEPATOCHOLANGIODUODENOSTOMY; — I: The gall-bladder has been excised, together with the junction of the cystic, hepatic, and common ducts. The posterior marginal sutures, uniting the divided ends of the ducts, are here passed so as to be knotted within (if they cannot be passed in the reverse direction) — two of such sutures being shown at **c**. The anterior marginal sutures are passed as shown at **d**. Margins and folds of adjacent hepatoduodenal ligament may be sutured around this junction for reinforcement. The raw bed from which the gall-bladder was excised is seen, together with two or three rather large open bile-ducts. The site in the vicinity of these bile openings is sutured to the duodenal opening by marginal sutures of the liver area, which become Lembert sutures of the areas surrounding the duodenal opening. The axial incision into the duodenum has been, here, prematurely made — as the intestine is usually not incised until the posterior layer of sutures (**a**) has been placed — after which the anterior layer, **b**, is placed. II: **e**, The sutured ends of the hepatic and common ducts, with a T-drain *in situ;* — **f**, the sutured hepatoduodenal anastomosis. The raw bed of the gall-bladder will be covered by the sutured together peritoneal flaps, as far as this is possible. (Modified from Kehr.)

After testing the ability to approximate the raw surface of the gall-bladder bed, or of a liver surface near to the site of the gall-bladder (especially seeking a site of enlarged bile-ducts), to the free portion of the duodenum, the posterior aspect of the selected liver site is sutured with catgut, to the outer coats of the duodenum parallel with and posterior to the incision which will be made through its coats. The duodenum is then axially incised, and the posterior free margin of the lip of the intestinal incision is sutured with catgut to the posterior aspect of the selected liver site, anteriorly to the line of sutures first placed. These steps are shown in Figs. 3722 and 3723. The two lines of sutures thus placed are now duplicated along the anterior aspect of the site of hepatocholangioduodenostomy _ the marginal line of sutures being carried through all the coats of the anterior border of the duodenum and reinforcing tier, through the superficial part of the raw bed of the gall-bladder (or the adjacent raw or cut surface of the liver) and the outer coats of the duodenum. In excising the gall-bladder the serous flaps are so planned as to enable these peritoneal flaps to be brought together by suture over the raw surface of that part of the liver bed not involved in the anastomosis with the duodenum.

The T-drain of the ducts is brought out of the abdominal wound _ along with the gauze drain of the site of union between the liver surface and the duodenum.

HEPATOCHOLANGIO-CYSTO-DUODENOSTOMY (INTRA-ABDOMINAL DRAINAGE OF THE BILE-DUCTS INTO THE DUODENUM VIA THE GALL-BLADDER)

Description.—In all cases where it is not necessary to sacrifice the gall-bladder _ and in cases where the gall-bladder is at all available, though partially involved _ it is generally considered better to utilize it as an intermediary link in the system of drainage between biliary ducts and the duodenum, than to drain directly from the biliary ducts into the duodenum, as carried out in the preceding operation. The object of the operation is accomplished through a twofold technic _ the performance of hepatocystostomy and cystoduodenostomy.

Operation.—It may be supposed that the hepatic duct is so involved that its obstruction is inoperable, as by a tumor, as suggested in Fig. 3724. The first step consists in planning a cholecystoduodenostomy in the usual manner, as already described and pictured (pp. 529–533). When, however, the opening is made in the aspect of the gall-bladder (its lower wall) opposite the duodenum, use is first made of this opening as a window through which to tunnel through the opposite (upper) wall of the gall-bladder into the substance of the liver by blunt dissection _ for the purpose of opening up some of the bile-ducts to drain into the gall-bladder through this artificial route. If any unusual bleeding occurs, the liver wound may be temporarily packed with gauze. The anastomosis between gall-bladder and the duodenum, at the junction of its first and second portions, is then performed in the ordinary manner. Before completing the closure of the cholecystoduodenostomy an absorbable drainage-tube may be inserted, from the liver to the duodenum, and held in place with a catgut suture. The general features of the operation are suggested, diagrammatically, in the illustration.

Comments.—Instead of tunneling through the upper wall of the gall-bladder into the liver by blunt dissection, the gall-bladder may be split open to such an extent as to admit of using the actual cautery-point without burning the margins of the gall-bladder incision through which the cautery is introduced. After this the excess of opening made in the gall-bladder for the

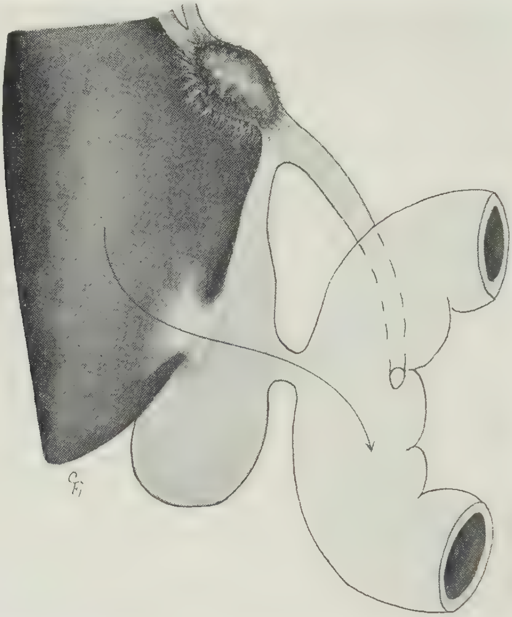


Fig. 3724.—Hepatocholangio-cysto-duodenostomy; _ The hepatocholangiocystostomy and the cysto-duodenostomy are shown diagrammatically. For details see text.

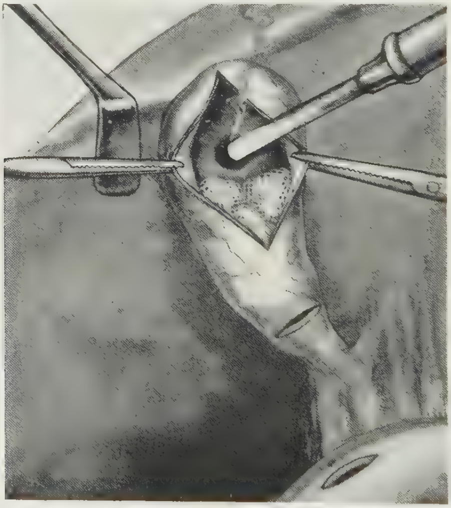


Fig. 3725.—Hepatocholangio-cysto-duodenostomy _ Accomplished by the Aid of the Actual Cautery After Splitting the Gall-bladder _ I; _ The fundus of the gall-bladder has been split, and its upper wall and the liver bored through by the cautery point. The incisions in the lower part of the gall-bladder and in the duodenum are shown.

purpose of burning out a communication with the substance of the liver with minimum hemorrhage is closed by a double tier of sutures down to leaving a gall-bladder opening commensurate with the duodenal opening with which it will be anastomosed. As a further modification (Fig. 3725), the fundus of the gall-bladder may be separately incised – the lips of the wound being held apart – the cautery used – and this gall-bladder wound closed by two tiers of sutures (the inner being catgut) – after which another incision is made upon the inferior aspect of the gall-bladder for anastomosing with the duodenal opening (Fig. 3726). Drainage into the duodenum by this method is, naturally, accomplished without the need of an interhepatoduodenal absorbable drain. Temporary gauze drainage of the site of these rather extensive procedures is wise.

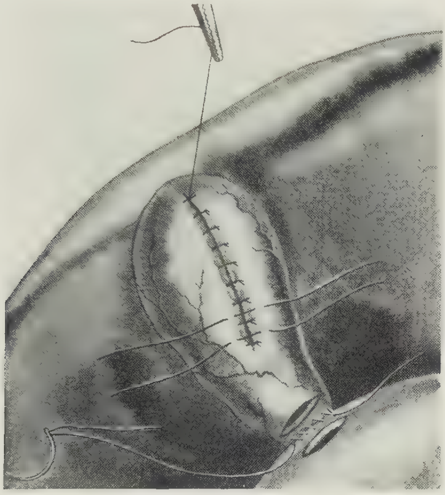


Fig. 3726.—The Same – II; – The gall-bladder wound is being closed by marginal and seromuscular lines of sutures. After the gall-bladder has been sutured a cholecystoduodenostomy is performed in the usual manner – the posterior tier of seromuscular suturing being here shown.

REMOVAL OF STONES FROM THE RIGHT OR LEFT HEPATIC DUCTS THROUGH AN OPENING IN THE DUCTUS HEPATICUS

Calculi may be discovered in the right or left hepatic ducts (see Fig. 3720) which are so high up as to be difficult of removal by direct approach. Stones situated in the right or left bile-duct have sometimes been removed by incising the ductus hepaticus exactly as in hepaticotomy (p. 564) – and then inserting special forceps through this opening and grasping the stone – as shown in Fig. 3727.

The forceps are made to serve a threefold rôle – their closed blades are first used as a probe for locating the stone – and then, by carefully separating the blades as the stone is approached, and especially as the blades pass over the sides of the stone, the bile-duct is preparatorily dilated sufficiently for the dislodgment and downward passage of the stone – and, finally, the stone, steadily grasped, is withdrawn. Immediate examination should always be made for other stones.

Upon the completion of the operation the question of suturing or draining the hepaticotomy wound will be decided according to the conditions and emergencies of the individual case – hepaticorrhaphy being described on p. 564 and hepaticostomy on p. 565.

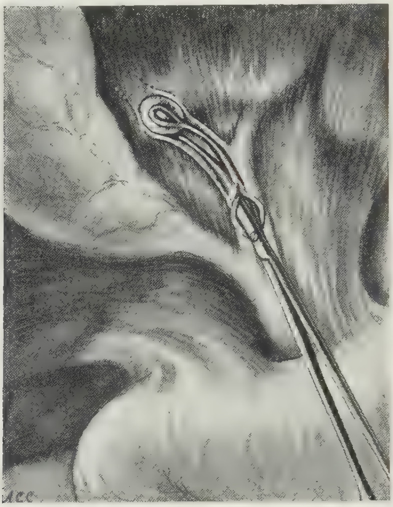


Fig. 3727.—Removing a Stone from the Right or Left Hepatic Duct by Means of Special Forceps Introduced Through an Incision in the Ductus Hepaticus.

HEPATICOTOMY FOR CALCULUS FOLLOWED BY HEPATICORRHAPHY

Description.—The incision of the hepatic duct followed by the immediate suture of the incised duct. The hepatic duct may be incised for the extraction of a calculus of the ductus hepaticus, or of the right or left bile-duct, or for exploration (by forceps introduced through the opening in the ductus hepaticus) _ following which it is ideal to suture the wound in the duct (if possible) _ but probably safer, in many instances, to drain temporarily (see Hepaticostomy, following). If the hepaticus cannot be drained directly, the drain may be carried into it through the incised choledochus. Operations upon the hepatic duct, however, are less frequently performed than are the corresponding operations upon the common duct.

Operation.—As the site of manipulation is very deep, an unusually free exposure should be made _ such as may be secured through an approach on the order of the angular incision. The liver is retracted well upward _ the portal vein located _ a finger carried into the lesser peritoneal cavity through the foramen of Winslow _ and the ductus hepaticus seized between the finger within and the finger without, isolated, and brought into the field. As in performing choledochotomy, followed by choledorrhaphy for the extraction of calculus, sutures may be first placed (v. Fig. 3747), and then drawn aside, as tractors, while the duct is being incised (to be afterward tied as sutures), _ or, if no stone be present, two silk stay-sutures may be placed, paralleling the line of future incision into the duct, and used as tractors while incising the duct _ after which the lips of the wound in the duct are sutured transversely, while being steadied in the grasp of forceps. The corresponding operations upon the common duct are shown in Figs. 3737–3759. The suturing should consist, where it is possible to mechanically apply them, of two tiers _ a fine catgut marginal suture of all the coats, and an outlying silk suture of the outer coats. If but one tier can be used, it should be of fine chromic catgut, and not include the innermost coat.

Comments.—When it is possible to do so, instead of incising the hepatic duct for the extraction of a calculus, it is an easier mechnical procedure (because of greater accessibility) to incise the common duct, and then digitally manipulate or "milk" the stone from the hepatic duct out through the opening, or within forceps reach or scoop reach of the opening in the common duct.

In the majority of cases of obstruction in which hepaticotomy is performed the hepatic duct has become sufficiently dilated to admit of the tip of the finger for its examination – even, sometimes, up to the right and left bile-ducts.

A single row of sutures restoring the incised hepatic duct is sometimes reinforced by suturing a fold of peritoineum over the suture line.

It may be impossible to satisfactorly expose the hepatic duct. If this be the case, and if, at the same time, it be indicated, for some good reason, to remove the gall-bladder, then, following the excision of the gall-bladder the cystic duct may be split open down to the junction of the hepatic duct. If, on the other hand, there be no reason for excising the gall-bladder, the gall-bladder may, nevertheless, be limitedly incised – and access be thus gotten, through the cystic duct by instrumentation, to the common and hepatic ducts, if possible – or the cystic duct may be slit open and subsequently repaired.

HEPATICOSTOMY OR DRAINAGE OF THE HEPATIC DUCT

Description.—Hepaticostomy, or hepaticus drainage, consists in the drainage of the ductus hepaticus. The operation is usually performed following hepaticotomy for calculus of the hepatic duct (described in the preceding operation) – in which, instead of suturing the incised duct, the opening in the hepatic duct, and, through it, the duct itself, is drained. As choledochotomy is preferable to hepaticotomy, so choledochostomy is preferable to hepaticostomy – in those cases where the operation upon the common duct will suffice to accomplish the object, and because of the greater accessibility of the common duct.

Hepaticus drainage may be accomplished in one of several ways – the most usual of which will be here mentioned:

Indirect External Hepaticostomy by Way of the Gall-bladder or Cystic Duct.—Two methods of accomplishing this may be utilized: – If the gall-bladder be available, a tube may be passed into the hepatic duct through an opening made in the fundus of the gall-bladder, and along the cystic duct, after which the fundus of the gall-bladder is attached to the lower plane of the abdominal wound, constituting a cholecystostomy. If the gall-bladder have been excised, then the rubber tube may be introduced into the hepatic duct by way of the divided cystic duct, which is tied around it – the rubber tube making its exit through the abdominal wound.

Direct External Hepaticostomy.—In this technic the dilated hepatic duct is sutured directly into the abdominal wound and opened – but the procedure is only mechanically possible when the duct is very considerably dilated, which is often the case.

Transhepatic External Hepaticostomy.—This is an application of the principle of hepatostomy, which has been described (p. 557). It is known that calculi may occur in the intrahepatic bile-ducts as well as in the extrahepatic biliary passages – and also that the hepatic duct may become very greatly enlarged by obstruction, which may be either internal (a stone within the duct) or external (a tumor without the duct). As a result of these conditions the outflow of bile is interfered with and cystic formations of the hepatic duct, or of the intrabiliary ducts may occur. One sometimes operates under the impression of dealing with an intrahepatic cyst of other origin – and finds such a condition present as above mentioned – and when this is cut into, before or after anchorage of the cyst wall or liver surface, to the abdominal wound, direct external transhepatic drainage of the liver (hepatostomy), or of the hepatic duct (hepaticostomy), as the case may be, is effected — or possibly of both, where dilated intrahepatic bile-ducts and dilated hepatic duct intercommunicate.

Hepatico-enterostomy (Hepaticoduodenostomy).—This technic will be separately described

HEPATICODUODENOSTOMY

MAYO'S TECHNIC

Description.—This form of hepaticostomy is accomplished by anastomosing the hepatic duct with the duodenum about 7.5 cm. (3 inches) from the pylorus. This method of conserving the bile-flow is applicable to certain cases where there is inoperable obstruction to the flow through the common duct, as where there has been destruction or loss of substance in the course of the common duct — and where, at the same time, the gall-bladder and cystic duct cannot, for some reason, be employed in connecting up the biliary tract. In some instances, as the one in which Mayo describes his technic, the gall-bladder had been removed at a previous operation.

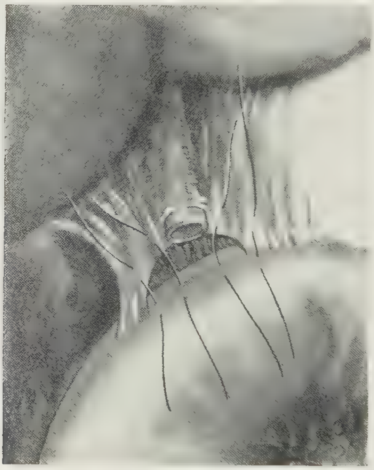


Fig. 3728.—Hepaticoduodenostomy — Mayo's Technic — I; — Suturing the duodenal site of anastomosis by seromuscular sutures to the adjacent bands of adhesion and to the connective tissue of the hepatoduodenal ligament, on each side of the divided hepatic duct — to take the strain off the anastomosis itself and to furnish reinforcement to the suture line.

Operation.—The mechanical steps of the operation are somewhat difficult — but some of the difficulties in making the anastomosis may be materially lessened by the very conditions which are apt to accompany such cases, namely, the presence of more or less extensive and stout adhesions in the region of operation — thereby furnishing resistant tissues for suturing in order to take some of the strain off the anastomosis itself. It will be supposed, as was the case in Mayo's instance, that the gall-bladder had been previously removed (which had been accomplished one year before, together with drainage of the common duct). The operation about to be described was performed for a subsequent biliary fistula.

The involved structures were exposed by an incision that paralleled the original one. A mass of dense, firm adhesions were found, in which the stomach, duodenum, and transverse colon were involved. The drainage tract was located, and traced down to the common duct, at the junction of the cystic duct. The hepatic duct was enlarged to the size of the index-finger, while the common duct was cicatrized down to a fibrous cord, with a scarcely detectable lumen. The duodenum was adherent to the fistulous tract, and made one of its deeper walls. The duodenum was mobilized, and the hepatic duct freed from both the fistulous tract and transversely severed from the deformed common duct. At a distance of about 7.5 cm. (3 inches) from the pylorus two or three seromuscular sutures were taken in the duodenal wall, corresponding to each side of the future site of anastomosis _ and the upper ends of the stitches were then carried through the rather extensive and resistant adhesions in the immediate neighborhood of the divided hepatic duct _ so that when these were tied there would be no strain upon the immediate hepaticoduodenostomy (Fig. 3728). Having controlled the duodenal flow on each side, the excision of a small elliptic piece of all the coats of the free aspect of the duodenum is made, corresponding in size with the divided hepatic duct, and in easy relation with it. These openings are now sutured together by what amounts to two rows of sutures of fine chromic catgut. The posterior sutures are, naturally, the hardest to place. These are carried from the mucous side, through all the coats of duct and duodenum, and knotted upon the mucosa. Then the sides and front are brought together _ each alternate suture passing through all the coats of each viscus, now from without inward and from within outward, and the next suture, through only the outer walls of duct and duodenum (Fig. 3729). The line of suturing is further reinforced by suturing the adjacent scar tissue and also the duodenum about it and especially gathering it about the posterior aspect of the anastomosis as well as possible, where only a single tier of sutures had been placed _ thus giving width and strength to the entire site of anastomosis. A rolled gutta-percha drain is introduced at the upper and lower angles of the abdominal wound _ but not carried down to the site of anastomosis. The rest of the abdominal wound is sutured. Satisfactory recovery followed in the case which furnished the basis of this description

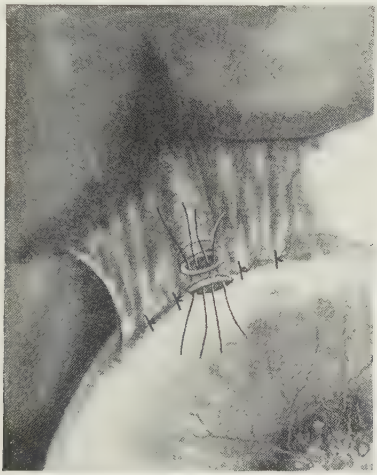
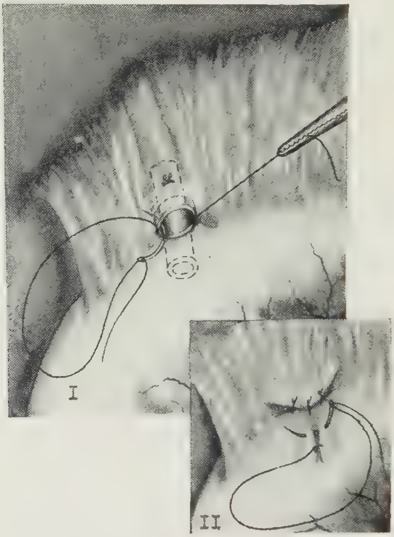


Fig. 3729.—The Same _ II; _ The hepatoduodenal ligament has been reefed down to the duodenum _ and the posterior through-and-through sutures placed.

Comments.—A short length of rubber tube is sometimes introduced into both viscera at the site of anastomosis, as a form over which to apply the sutures; the tube being subsequently passed, when its anchoring suture is dissolved (Fig. 3730, I). The neighboring wall of the duodenum, when not already tensed by traction, may sometimes be used, as Mayo has done, for reinforcing the site of anastomosis (Fig. 3731, II).

The method is applicable when the liver end of the duct and the duodenum can be approximated without tension. The opened distal end of the duct is ligated. If there be sufficient lumen, or if additional room can be secured by stretching the distal piece by opening the blades of a pair of forceps within it, it might be well to invert the free end, with or without ligation, and then close the inverted end by suture.



Figs. 3730 and 3731.—Hepaticoduodenostomy by the Aid of a Rubber Tube:—I, A small length of rubber tube has been anchored, with a catgut stitch, into the opened end of the hepatic duct, to serve as a form over which to suture together the ducts hepaticus and duodenum; the tube being afterward passed. II, Suturing the duodenal wall and the hepatoduodenal ligament about the site of anastomosis by folding their walls over the site of anastomosis.

HEPATICUS DRAINAGE BY MEANS OF A T-TUBE

This method of drainage has been described under the excision of the gall-bladder with following hepaticus drainage (p. 548); and, further, is the same in principle and general execution as the T-drainage of the common duct described and pictured at p. 581.

The upper part of the transverse limb of the T-drain is generally longer than the lower limb in drainage of the hepatic duct; for ease of manipulation.

The opening for drainage of the hepatic duct is sometimes made in the common duct; after which the upper limb of the T-drain is made to enter the wound in the common duct, and is then pushed upward into the hepatic duct.

Sometimes a straight rubber tube is used; the end of which, after entering the opening in either hepatic or common duct, is pushed upward in the direction of the liver.

WOUNDS OF THE HEPATIC DUCT

These are treated, in general principle, as are wounds of the common duct (v. p. 599) _ except that they are even more inaccessible.

HEPATICOLITHOTRIPSY

Description.—The above expression has been used to describe a technic whereby a calculus in the hepatic duct is crushed *in situ* _ after which the fragments are removed through an incision made in the common duct. The procedure has been successfully carried out in some cases where it was difficult, or impossible, to secure exposure to safely make the incision directly over the stone through the wall of the hepatic duct.

Theoretically, the operation is objectionable upon the score of possible wounding of the wall of the hepatic duct with fragments of the broken stone _ and, surgically, it is uninviting to choose, in preference to the direct cut down upon the stone _ but in spite of these objections the operation has been successfully performed by good operators.

Kocher writes: "The method is worth trying in difficult cases; the results have all been good, and the theoretic objections brought against it have been proved to be groundless."

None of the writers whom the Author has consulted have stated by what means the crushing was accomplished. It is, however, to be supposed that one would first make the attempt to grasp the stone between finger and thumb and push it on into the common duct _ and, failing in this, to then try to break the stone between the same two fingers which had failed to dislodge it downward _ and that, still failing, it would be admissible to gently and carefully try to crush it, through the walls of the duct, by grasping the duct between the rubber-guarded blades of a pair of dressing or other special forceps.

PROBING FOR STONES IN THE CYSTIC DUCT, AND THEIR REMOVAL BY FORCEPS THROUGH THE INCISED GALL-BLADDER

It will often happen that one will seek to determine, by probing through an opening in the fundus of the gall-bladder, whether a calculus is lodged at the neck of the gall-bladder, or in some part of the course of the cystic duct _ and, if found, an attempt is generally made to withdraw it through the bladder wound by means of appropriate forceps.

The attempt to discover and remove such stones is usually made when the abdomen is opened _ and, under these circumstances, one has the additional aid of finger manipulation outside of the cystic duct. And also, under these circumstances, if it be impossible to remove one or more stones so placed through the wound in the gall-bladder, one may proceed to cut directly down through the duct for the removal of an impacted calculus.

If, on the other hand, a cholecystostomy have been performed, there is only the cholecystostomy wound through which to manipulate _ unless the abdomen is reopened.

In Fig. 3732 is shown how carefully and patiently one must often proceed in probing the cystic duct _ where the duct may be doubled upon itself by the probe, and apparently come to a blind end, when the stone may lie just beyond the artificially made angulation.

In Fig. 3733 the method of extraction of a stone from the cystic duct by means of special forceps is illustrated. Even when the stone may have been plainly demonstrated to be present, it may often be very hard to grasp it with the forceps. It may be possible to make this easier, if one will gradually, at intervals in the advance, open up the blades of the forceps limitedly — as one stretches the finger of a glove — so that when the stone is reached it can

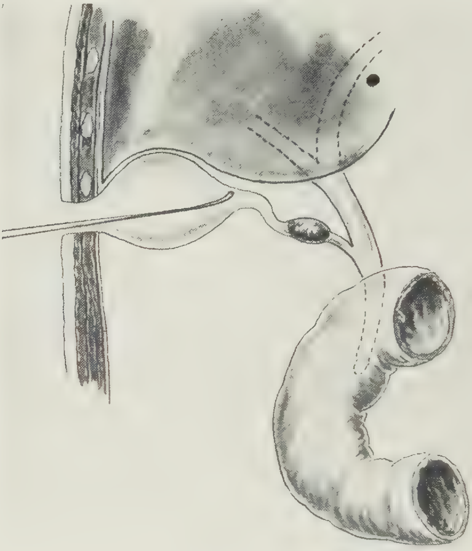


Fig. 3732.—Probing the Cystic Duct Through the Incised Fundus of the Anchored Gall-bladder in Examination for Calculi; — It will be seen that unless the probe be carefully manipulated, and variously bent and twisted, a stone, though present, may escape detection.

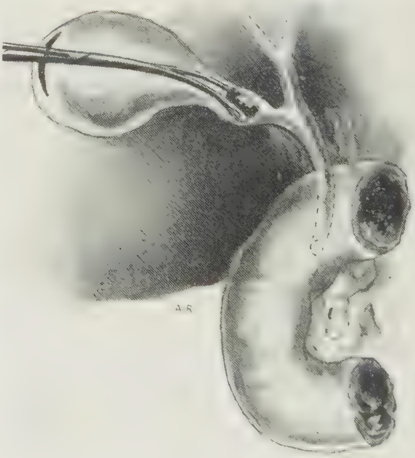


Fig. 3733.—Removing a Calculus from the Cystic Duct by Means of Special Forceps Through the Incised Gall-bladder.

be grasped, and the distal passage along which it must be withdrawn will have been dilated in preparation for its withdrawal.

RETROGRADE PROBING OF THE HEPATIC DUCT AND DIRECT PROBING OF THE COMMON DUCT VIA THE GALL-BLADDER AND CYSTIC DUCT THROUGH AN OPENING IN THE GALL-BLADDER

These probings may be made via the gall-bladder and cystic duct through an opening in the fundus of the former, usually in connection with cholecystostomy _ and, in this connection, the technic is mentioned under the operations upon the cystic duct.

But retrograde probing of the hepatic duct and direct probing of the common duct may be carried on through an opening made into the biliary tract in other parts of its course _ as through the cystic duct and through the upper part of the common duct.

In retrograde probing with an angulated probe (Fig. 3734) one must be assured of sufficient patency of the course along which the bent probe is to pass to allow of its withdrawal, otherwise the short arm might separate from the long arm far enough to prove an embarrassing problem, or, without separating, catch into an obstacle which would prevent its withdrawal. It is conceivable that the probe could be made of such composition and thickness that it would, after accomplishing its object, straighten out as soon as it was subjected to the force of withdrawal.

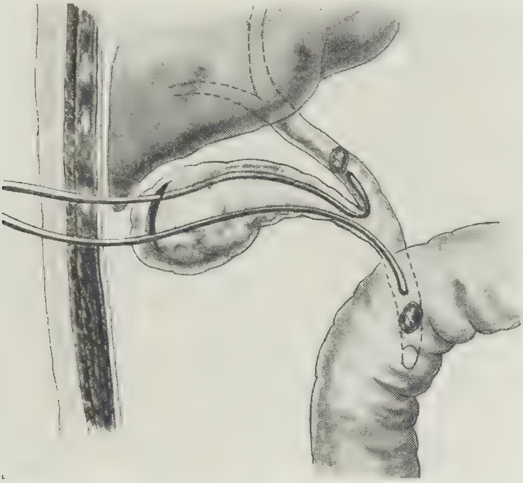


Fig. 3734.—Retrograde Probing of the Hepatic Duct, and Direct Probing of the Common Duct via the Gall-bladder and Cystic Duct Through an Opening in the Gall-bladder. (Both probings are simultaneously shown in the one picture for the convenience of space.)

In direct probing (Fig. 3734) no such difficulty is experienced _ as, under favorable circumstances, the probe may be passed from the fundus of the gall-bladder (or from any intervening part of the tract) into the duodenum. Such a long passage, however, may not be easy to accomplish _ for it has been shown how the probe may be blocked in passing through the cystic duct alone by the normal mucous folds.

Passages from openings made nearer the site to be probed are, naturally, more readily negotiated.

CYSTICOTOMY, OR INCISION OF THE DUCTUS CYSTICUS, FOR STONE, FOLLOWED BY CYSTICORRHAPHY OR SUTURE OF THE DUCT

Description.—A stone in the cystic duct may be operated upon in one of several ways: _ An attempt may be made to dislodge it, by digital manipulation, into the common duct, or back into the gall-bladder; _ an attempt may be made to accomplish cysticolithotripsy, in the same manner as hepaticolithotripsy is performed (p. 569); _ or the cystic duct, and as much of the gall-bladder as necessary, may be incised, the stone extracted _ and the wound in duct and gall-bladder sutured at once and entirely, or the wound may be sutured down to the exit of a rubber-tube drain.

Cholecystostomy is sometimes performed in these cases _ after the removal of the stone by scoop or forceps. Cholecystectomy is also often carried out, especially when the walls of gall-bladder and duct are markedly diseased.

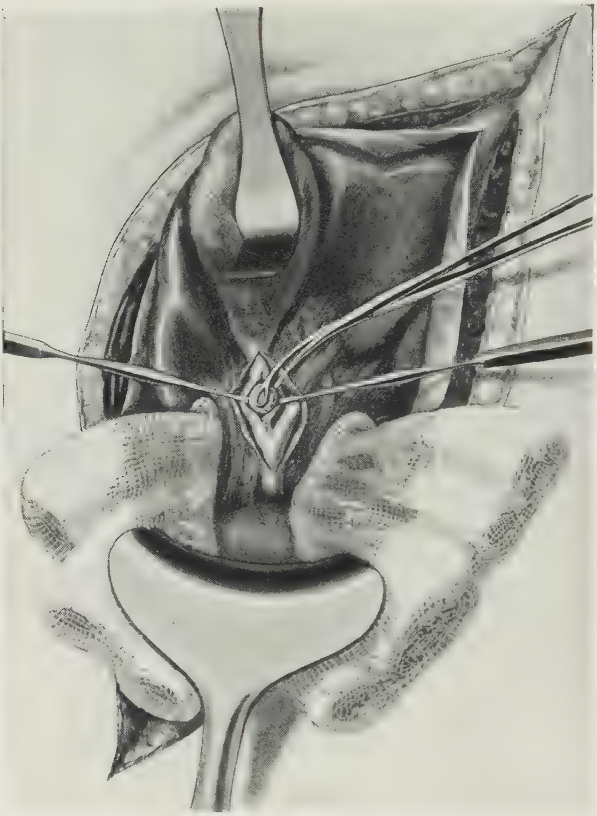


Fig. 3735.—Cysticotomy, or Incision of the Cystic Duct, for Calculus; _ The margins of the wound are carefully retracted _ and calculus forceps are removing a stone _ after which, in clean cases, the duct is ordinarily sutured _ as well as the incised overlying hepatoduodenal ligament.

In performing cysticotomy it is ideal to follow the extraction of the stone by complete suturing of the wounded duct _ and this may be undertaken if the parts be in good condition. If, on the other hand, distinct infection or disease of the walls of the biliary tract be present, drainage is wiser (cysticotomy).

Operation.—Cysticotomy, in the comparatively rare cases in which it is performed, is accomplished, in principle, as is the extraction of stones from the other ducts by direct incision. The stone is first located by palpation _ after which it may sometimes be removed by a limited incision made through the wall of the cystic duct directly over it (Fig 3735). In other cases some extent of the wall of the gall-bladder neck may have to be first incised _ and, on a grooved director introduced into this, the cystic duct is split open _ and the stone removed by scoop or forceps. The patency of the biliary tract, however, cannot be considered established until this has been demonstrated by probing. Finally, if it be concluded to suture the wounded duct, this is done with fine chromic catgut, which is passed with avoidance of the mucosa, in interrupted or continuous stitch (Fig. 3736). And it is safer to follow this by a second tier of sutures, of fine silk or celluloid, passing through the outer coats, provided this can be done without too much encroachment upon the lumen of the duct.

Some Operators temporarily drain the fundus of the gall-bladder (cholecystostomy), whenever they follow incision of the cystic duct by suturing its walls. As mentioned above, when the wound in the cystic duct is not sutured entirely, it is at least sutured up to the exit of a T-drain, which then serves the rôle of the safety-valve drainage from the fundus, secured in the classical type of cholecystostomy.

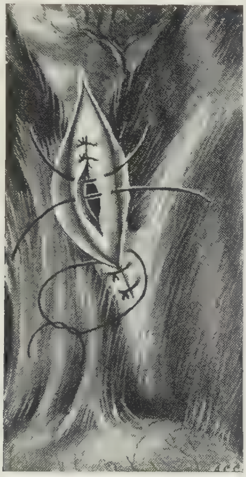


Fig. 3736.—Cysticorrhaphy, or Suture of the Cystic Duct _ Following Cysticotomy, or Incision of the Cystic Duct, for the Extraction of Calculus; _ Interrupted sutures are seen passing through the outer coats of the cystic duct, avoiding the mucosa _ and an overlying layer of interrupted sutures passing through the incised margins of the hepatoduodenal ligament, including, or not, the fibrous coat of the cystic duct.

Comments.—An attempt should be made to displace back into the gall-bladder, or onward into the common duct, a stone impacted in the cystic duct, before resorting to any cutting operation _ and the gall-bladder should not be cut into before trying to force a stone from the cystic duct into the gall-bladder, as the maneuver is more easily accomplished by digital manipulation while the gall-bladder is partly distended.

Often when it is impossible to dislodge a stone during operation, it will subsequently, within a few days, be discharged through the cholecystostomy wound, especially if the rubber tube be large. To aid in its expulsion, warm sterile soap solution, or warm sterile olive oil may be thrown into the gall-bladder, to promote its partial dissolving and discharge.

SUPRADUODENAL CHOLEDOCHOTOMY FOR CALCULUS, FOLLOWED BY CHOLEDOCHORRHAPHY

Description.—The incision of the free portion of the common duct, between the junction of the hepatic and cystic ducts, above, and the upper border of the first portion of the duodenum, below _ followed by the suturing of the incised duct. The object of the operation is usually either the extraction of a stone at the site of incision, or the removal, through this incision, of a stone within reach of it, above or below. Where the operation is performed for stone, and no infection be present (an unusual status), it is ideal to immediately follow the extraction of the stone by the suturing of the wounded duct without drainage (choledochorrhaphy). In many cases, however, it is wiser to establish temporary drainage after removing the calculus _ and in other cases, as in infection, direct drainage from the duct is planned from the first (choledochostomy) _ and this combination of the two technics will be next considered. In some cases, however, indirect drainage is carried out in connection with choledochotomy, that is, drainage of the biliary tract by way of the gall-bladder (cholecystostomy or cholecystoduodenostomy) _ and in these cases the choledochotomy may be immediately followed by choledochorrhaphy.

Kocher considers that the only circumstances which contraindicate primary suturing of the incised common duct are suppurative cholangitis and cholecystitis.

Operation.—The site of operation is often reached and exposed in the course of some procedure about the liver or gall-passages, undertaken for some other purpose. Where especially planned for the purpose of removing a stone from the common duct several incisions lend themselves satisfactorily to the purpose _ Kehr's wave incision (p. 494) _ Kocher's oblique subcostal incision (p. 441) _ Kocher's angular incision (p. 499) _ Bevan's incision (p. 503). The intercosto-abdominal nerves should be preserved.

The abdomen having been opened _ the liver retracted well upward _ the intestines depressed (or having fallen away in the reversed Trendelenburg position) _ the gall-bladder is exposed. The bladder is then first palpated for calculi _ and the cystic and hepatic ducts are followed down until the common duct is reached _ manipulating in the manner described below. All adhesions present should be broken down by blunt dissection, or divided between chromic gut ligatures. These adhesions are apt to be found between gall-bladder, stomach, transverse colon, great omentum, and duodenum. The entire area should be packed off with gauze. By means of a piece of gauze the liver and gall-bladder are grasped, drawn down from under the costal arch, and rotated in such a way as to stretch and make prominent the common duct and bring it nearer the surface.

After tracing down the cystic duct, expose the anterior surface of the hepatoduodenal ligament down to the duodenum _ demonstrate the free border of the ligamentum hepatoduodenale to the right _ insert the left index-finger into the foramen of Winslow (with pulp of finger forward) and left thumb upon the anterior surface of this ligament _ follow its structure downward to the duodenum, having, between the fingers, the common duct to the right, the hepatic artery to the left, and the vena portæ on a plane posterior to and between the other two.

Having located the stone by the above method of palpation, especially guard against its slipping into the hepatic duct from between the thumb and index _ by pressing it forward against the anterior wall of the duct and steadying it in that position (Fig. 3737). Incise the duct in its long axis, directly over the stone, for a distance of from 1 to 3 cm. ($\frac{1}{3}$–$1\frac{1}{4}$ inches), as indicated

(Fig. 3738). The escaping bile is caught in gauze _ and the presenting calculus removed with special forceps or scoop. Having removed the stone, by forceps or scoop, the common duct should be examined for other stones _ by means of the finger or probe _ and from the duodenum to and into the cystic and hepatic ducts.

In those non-infected cases where immediate closure of the incised wound of the common duct is to be carried out, suturing is proceeded with at once. Operators differ somewhat in the technic of suturing the common duct. There are several recognized methods of suturing _ as far as the manner of penetrating the layers of the duct wall is concerned. And there are several mechanical devices, or methods, as aids in the placing and tying of the stitches.

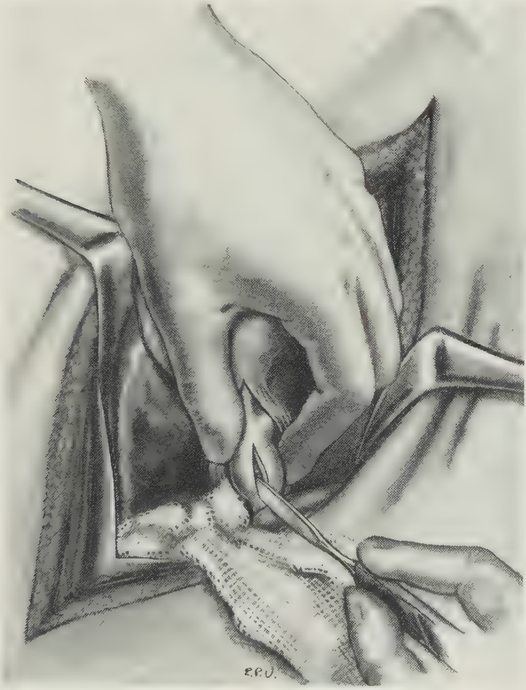


Fig. 3737.—Supraduodenal Choledochotomy for Calculus _ I; _ Steadying the common duct with left thumb and forefinger, while incising its wall directly over the stone.

In probably the most frequently employed method of choledochorrhaphy, fine catgut, on a small, curved needle, held in a holder, is carried through the margin of all the coats, as a first tier (Fig. 3739, **a**). These interrupted sutures are then tied. An outer reinforcing tier of non-penetrating, seromuscular sutures is then placed (Fig. 3740, **b**) _ and tied. This is the method adopted by Kocher and others. The first tier may be of fine chromic gut. The second tier may be of silk, Pagenstecher, or fine chromic catgut. Sometimes the incision over the stone is made transversely, or obliquely, according to the contour of the part, and, in such instances, the stitches are placed to cross the margins at a right angle.

Kehr's method is to first suture the margins of the mucosa of the incised duct together with fine catgut _ of which he writes, "The first suture of the mucosa is the most important, and should alone be proof against leakage" _

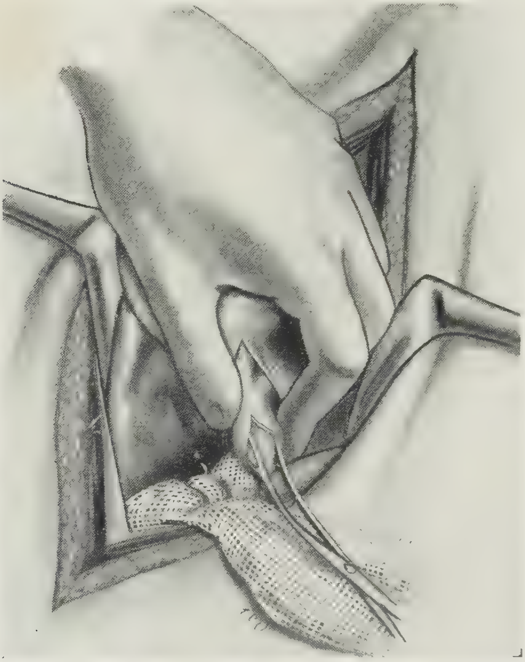
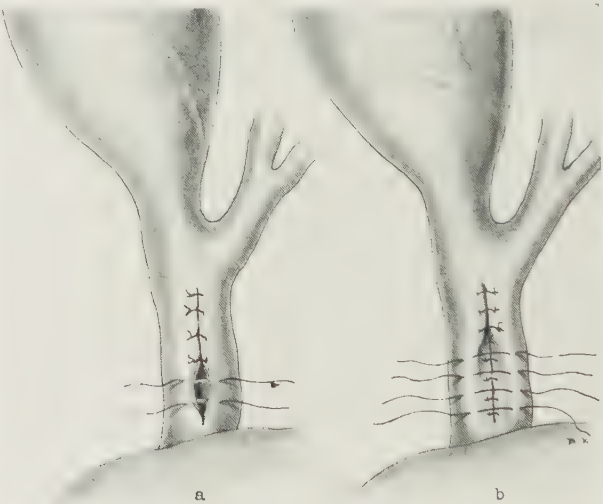
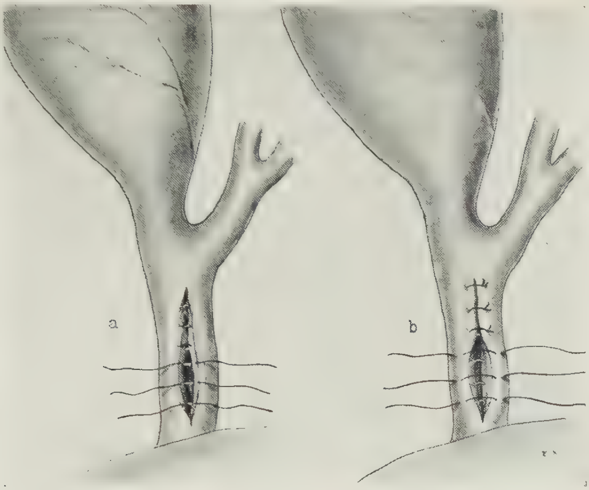


Fig 3738.—The Same – II; – Extracting the stone from the incised common duct by **means of forceps.**

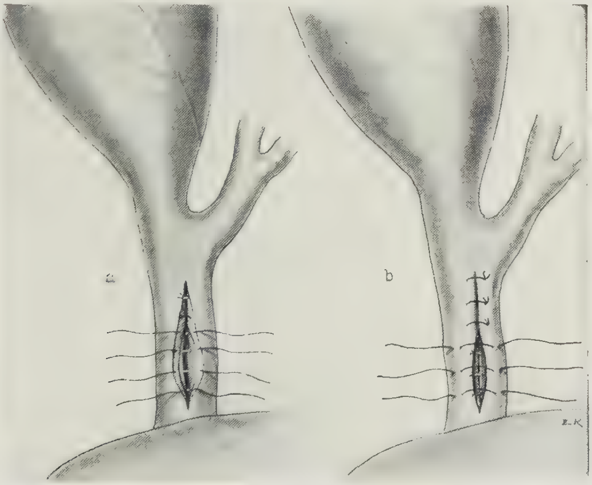


Figs. 3739 and 3740.—Suturing the Incised Common Duct by an Inner Tier of all the Coats – and an Outer Tier of Seromuscular Sutures: – **a,** Inner, marginal row of all the coats; – **b,** the inner row is shown tied – and some of the outer tier of non-penetrating, non-marginal, seromuscular sutures are placed.

as seen in Fig. 3741, a. This tier is tied. The second tier is also of catgut, but does not include any portion of the margins. It passes through only the serosa and muscularis of each side, avoiding the borders of the wound – as shown in Fig. 3742, **b**. When this tier is tied the appearance is practically the same as in the final tying by any of the other methods. Naturally, a Lembert suture will turn in a larger proportion of the outer aspect of the duct wall adjacent to the incision.



Figs. 3741 and 3742.—Suturing the Incised Common Duct by an Inner Row of the Mucosal Margins, and an Outer Non-marginal, Seromuscular Row (Kehr): — **a,** The mucosal margins sutured; — **b**, the mucosal tier tied; — **c,** non-penetrating, non-marginal tier passing through the serosa and muscularis.



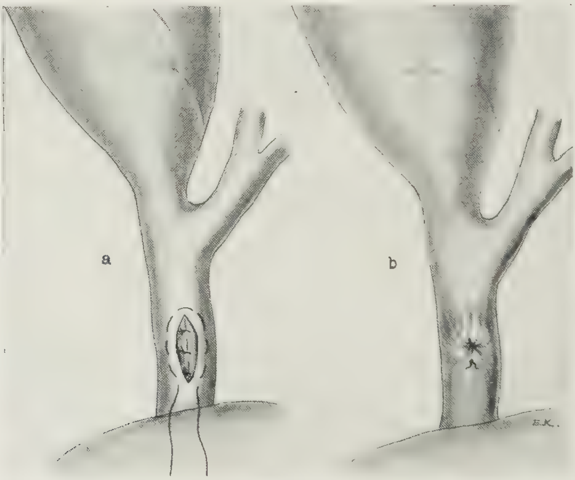
Figs. 3743 and 3744.—Suturing the Incised Common Duct by a First Row of Suture. Through the Two Inner Coats, Followed by a Second, Non-penetrating, Non-marginal Row Through the Serous and Muscular Coats: — **a,** Sutures of the inner coats (muscularis and mucosa); — **b,** the first row of sutures tied — and the second row of non-penetrating, non-marginal seromuscular sutures, partly placed, partly tied.

Upon the principle of avoiding the penetration of the lumen by the stitch, many Surgeons pass the first tier of sutures through serosa and muscularis only (Fig. 3743, a), leaving the margins of the incision in the mucosa unsutured. The second tier is of seromuscular stitches, avoiding the margins, as in the last method — and are seen, untied, in Fig. 3744, **b**.

Robson's method of suturing the incised coledochus is to close the margins of the mucosa and muscularis by a line of continuous catgut stitches — followed by a chromic gut purse-string suture of the overlying peritoneal coat — the technic being shown in Figs. 3745 and 3746.

The usual method of manipulating the margins of the incised duct, with forceps, while passing the needle and suture, usually suffices. Other mechanical aids, however, are also employed in placing the sutures.

One method of securing mechanical aid in passing the sutures is as follows: — Having incised the duct over the stone, before the stone is removed, the first tier of sutures, carried upon a small, fully curved needle through the serous and muscular coats, and through the free margins of these coats, is passed while the stone is still *in situ* (using the stone as a distender of the duct). These stitches are then held apart, and the stone is withdrawn, with forceps, between them (Fig. 3747). This row of stitches is then tied, serving as the first marginal tier. The second tier then consists of non-penetrating, seromuscular sutures. The first tier of fine catgut may penetrate all the coats if desired.



Figs. 3745 and 3746.—Suturing of the Incised Common Duct by a First Row of Stitches Through the Margins of the Mucosa and Muscularis — Followed by a Purse-string Suture of the Serosa (Robson).

Suturing the incised duct by the aid of Halsted's hammer was once much used, and still remains a good mechanical device. These hammers were made of different sizes, and L shaped (rather than T shaped), for ease of withdrawal. The method of using these is as follows: — Preliminary to the incision two traction-sutures are inserted on either side of the line of the future incision, through the outer coats of the duct — for the purpose of aiding the manipulation. Having evacuated the duct and examined its cavity for other calculi, Halsted's hammer is introduced by insinuating its longer arm into the incised wound — the hammer portion distending the duct and rendering it easier to suture its walls over the round, firm form — which also obstructs the flow of bile during the operation (Fig. 3748). The opening is finally closed by two rows of sutures – an inner row of interrupted gut sutures through the muscular and external coats, without penetrating the mucous membrane – and an outer row of interrupted silk sutures through the serous surfaces. The peritoneum covering the anterior aspect of the hepatoduodenal ligament is included in the suturing.

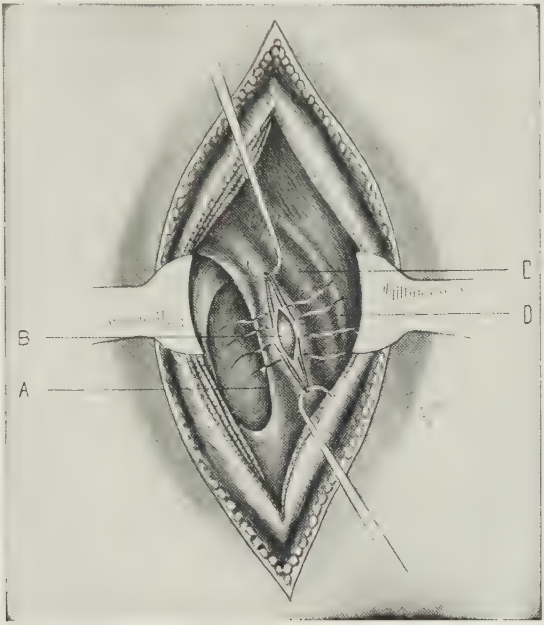


Fig. 3747.—Choledochotomy and Choledochorrhaphy by Vertical Subcostal Incision – Here Shown in Right Linea Semilunaris: – A, Foramen of Winslow, leading behind hepatoduodenal ligament; B, distended common bile-duct incised over a calculus. Lembert interrupted sutures are shown placed ready to be tied after extraction of stone; C, position of vena portæ; D, position of hepatic artery. Through-and-through marginal sutures should precede the Lemberts where the duct is large enough.

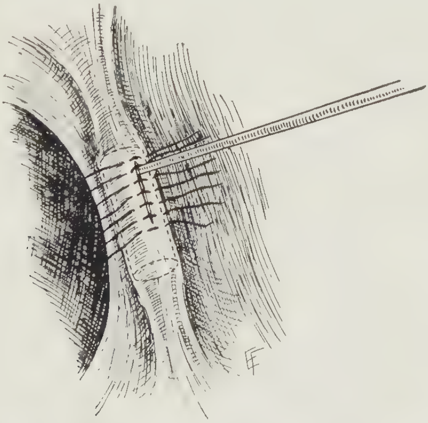


Fig. 3748.—Choledochorrhaphy Aided by Halsted's Hammer; – The hammer is shown *in situ* during placing of sutures – and is withdrawn prior to tightening last of the sutures.

If an artificial aid in suturing be deemed necessary, one nearly always at hand may be readily provided – in the form of a short length of rubber tubing, of the desired size, tied at one end by silk carried through with a needle. It is placed in position within the incised duct, with forceps – and, at the end of the operation, withdrawn by means of the silk-tractor, between the temporarily held-apart stitches which have been placed over its form. This device, in connection with partial choledochectomy, is especially useful.

In concluding the operation, the abdomen may be closed, in non-infected cases – but probably the majority of Surgeons institute temporary drainage for a couple of days – in the form of cigar-drain, of gauze wrapped in rubber tissue, conducted from the sutured duct, out through the abdominal wound, to carry away any leakage.

Comments.—After opening the common duct and removing the stone in evidence, digital and instrumental examination should be invariably made of all the other ducts, from their beginning to their end, before concluding the operation.

By lifting and rotating the liver, between the left thumb and forefinger, the common duct may be rendered very accessible – unless the case be markedly complicated by adhesions.

In working in the neighborhood of the portal vein only blunt dissection should be used.

There is generally a gush of bile on opening the common duct – and this bile is usually infective – so that ample provision should be made against soiling.

If the common duct be much distended, the excess of bile may be aspirated before making the incision.

Robson usually drains the right kidney pouch for forty-eight hours in cases where many adhesions have been separated, even independently of fear of leakage from the common-duct wound – by a stab-wound made 7.5 to 10 cm. (3–4 inches) to the outer side of the main abdominal wound – and through the same wound he conducts any drain which may issue from the gall-bladder or the common duct.

It is notable that Kehr records having left concretions behind in 16.6 per cent. of the cases upon which he operated – emphasizing the importance of the most rigid examination of the biliary tracts before coming to the conclusion that the operation has been satisfactorily completed. Robson relies upon the passage of the probe, scoop, and finger within the ducts, accompanied by digital palpation outside of the ducts. He even enters the right and left primary hepatic ducts.

Where choledochotomy, with suture of the incised duct is performed, cholecystostomy is frequently done at the same time – both to serve as a drain for the biliary system, and to relive the tension upon the stitches in the common duct.

It is easier to suture a thickened duct, and harder to suture a thin one. If it be impossible to suture the duct, or in emergency, anchor one end of a rubber tube within the duct wound, with a catgut suture, and pack this around with gauze strips – conducting both out of the abdominal wound. Fistulæ such as result from such methods tend to heal.

If the stone can be shifted, it is better to push it nearer the duodenum before incising the duct – as there is less danger of wounding the vena portæ.

After incising the duct it may be necessary to crush the stone *in situ* by inserting special crushing forceps through the wound in the duct, and then removing the débris with scoop or forceps.

One should always ascertain, by means of a probe, whether the duct into the duodenum is patulous.

In the majority of cases opening the common duct in its supraduodenal part suffices, as the stone is either lodged here or is sufficiently movable to be displaced to this site and thence removed. It is where this cannot be accomplished that the duct is opened in some other position.

At the time that the duct is incised the outflow of the bile may be largely controlled by the left index-finger which has been passed through the foramen of Winslow into the lesser peritoneal cavity.

In examining the duct by finger a finger-cot should be worn over the glove, as the bile is probably infected.

If there be doubt as to whether the opening of the duct into the duodenum is patent, this may be decided affirmatively by being able to fill the duodenum with water by means of a catheter introduced through the common duct wound.

Moynihan has laid stress upon the technic of *rotation of the duct*, in order to bring that structure into accessible position in cases complicated by small, shrunken gall-bladders, and by marked adhesions – and especially in patients in bad condition, where delay is not well tolerated. His description is as follows, – "But by the method I have often used, for which I suggest the term 'rotation of the duct,' the adhesions are ignored and the stone is yet easily removed. As soon as the condition of things is seen, the left hand of the Surgeon is passed transversely inward, in front of the pylorus and above the stomach, along the gastrohepatic omentum. When the hand is well placed, the fingers are flexed and the hand and wrist bent over to the patient's left, with the result that the common duct is twisted up into the wound and can be readily incised."

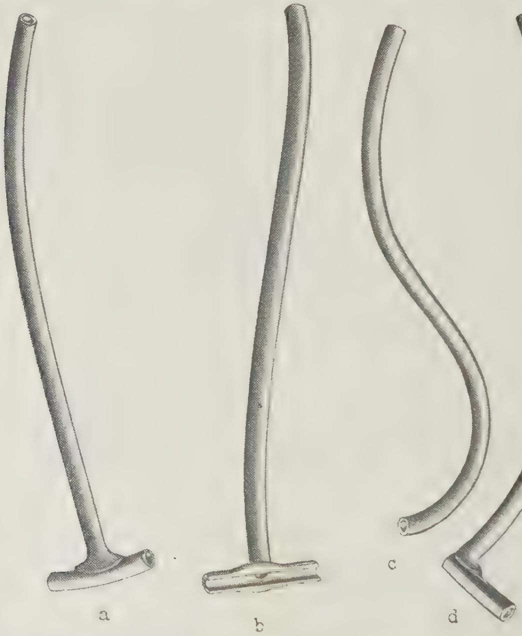
SUPRADUODENAL CHOLEDOCHOTOMY FOR CALCULUS OR INFECTION – FOLLOWED BY COMMON DUCT DRAINAGE (CHOLEDOCHOSTOMY)

Description.—The incision of the free portion of the common duct, between the junction of the hepatic and cystic ducts, above, and the upper level of the first portion of the duodenum, below (Fig. 3720, **h**) – followed by drainage of the common duct or choledochostomy. Incision for drainage of the common duct may be undertaken for this purpose alone – as in cases of infection of the biliary tract, and in which other methods of drainage (as by the gall-bladder route) are not available. But drainage of the common duct is usually undertaken where the common duct has been incised, primarily, for the extraction of calculus – and where, following the extraction, it is considered wiser to drain than to close the duct by suture. Two forms of drainage are employed.

Direct drainage of the common duct is the method followed, after incision of the duct for the extraction of stone, when a rubber tube is anchored into the opening made for the extraction of the stone, and is conducted, thence, out through the abdominal wound. Indirect drainage of the common duct is the procedure adopted when, following the incision of the duct, as for the removal of a calculus, the wounded duct is closed by suture (precisely as in the operation last described) – and the biliary tract is drained by cholecystostomy, through the gall-bladder, or through the divided cystic duct, when the gall-bladder is removed.

As to which cases should be drained, and which not, after incising the common duct, there is no consensus of view – the majority, however, undoubtedly leaning in the direction of drainage. Moynihan writes – "There does not seem to be any general agreement even yet among Surgeons as to the propriety or advisability of adopting drainage after the removal of a stone from the common duct. For my own part I never consider it safe to attempt the complete closure of a wound in the duct. I drain the duct invariably." He then quotes a number of recognized workers in this field – the minority favoring closure, and the majority, drainage. Kocher's views on the side of suture of the wound are given under the preceding operation.

As to whether one drains directly from the incised common duct, or indirectly through the gall-bladder (or cystic duct stump), is also a matter of individual judgment. The latter (where the gall-bladder is available) relieves the site of the wounded duct free of tension. Apparently, the majority of Surgeons favor direct drainage.



Figs. 3749–3752.—Forms of Rubber Tube Drains Used in Drainage of the Biliary Ducts: – **a,** Tubal T-drain; – **b,** combined tubal and split T-drain; – **c,** ordinary tubal drain; – **d,** L-shaped tubal drain.

Nothing further will, therefore, be here said as to choledochotomy with indirect drainage – for choledochotomy, with choledochorrhaphy, has been described at p. 574, and cholecystostomy, at p. 508 – and these combined procedures constitute the technic.

Choledochotomy, followed by direct drainage, or choledochostomy, will be here given – but as the choledochotomy part of the operation is exactly the same as described in the last operation (p. 574), only the direct drainage of the common duct (choledochostomy) will be gone into here.

There are four main kinds of rubber tubal drains generally used in the direct drainage of the biliary tract – and different sizes of each kind. The tubal T-drain is seen in Fig. 3749, **a** – the tubal feature being complete in longer and shorter limbs. In Fig. 3750, **b** a split T-drain is shown. The longer limb may be tubal, and the shorter limb, split – which makes this limb more pliable on withdrawal _ and while it may sometimes favor drainage over and above the other, it may, at least conceivably, impede drainage, by the sinking in of the wall of the duct into the trough of the split tube. In Fig. 3751, **c** an ordinary rubber tube is seen _ the features of whose usage are that its end must be most certainly introduced in the direction of the source of the bile flow (for it may easily slip into the opposite direction), and that it must be anchored with an absorbable stitch into the incised duct which is to be sutured about it. The L-shaped tube is simply a modification of the T-tube (Fig. 3752, **d**).

Direct Drainage of the Incised Supraduodenal Portion of the Ductus Choledochus.—Having incised the common duct and removed the stone in the manner described in the last operation _ or having incised the duct for other than calculous conditions _ and found direct drainage of the duct indicated, the introduction of the drain may be accomplished in one of several ways: _

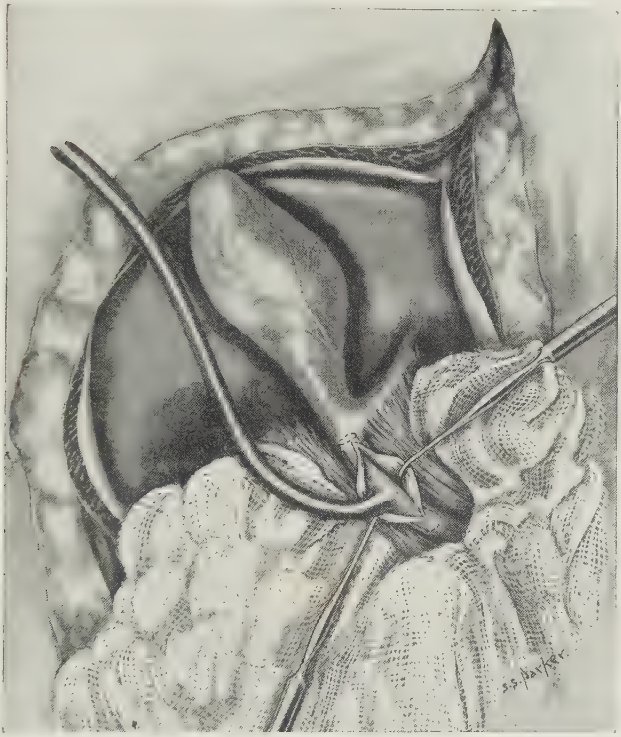
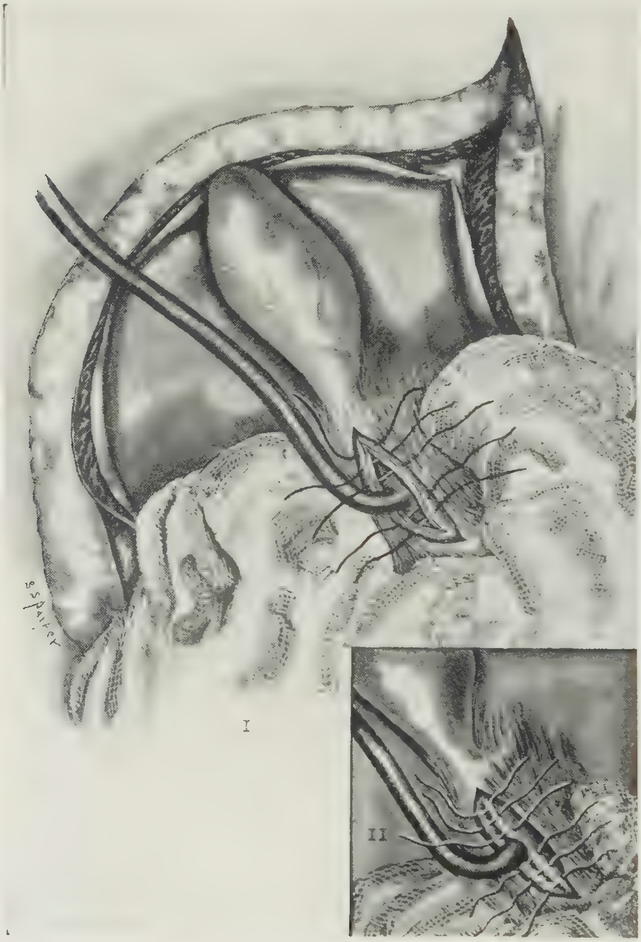


Fig. 3753.—Direct T-Drainage of the Incised Supraduodenal Portion of the Ductus Choledochus _ I; _ The T-drain is introduced into the incised choledochus by means of forceps, grasping the rubber drain at the cross-section of the tubes _ but omitted here for the sake of clearness _ while the lips of the incision are being retracted with wound hooks.

The T-drain (full tubal or half-split) is inserted as follows: _ While the lips of the incision in the duct are held apart with forceps, or retractors, the shorter arm of the T-tube is carried into the duct _ after which it is pushed toward the proximal end of the biliary tract until the longer limb of the tube is stopped by the upper end of the incision and is hugged in the upper angle of the incision (Fig. 3753). While the lips of the incision are steadied, in turn, with forceps, fine interrupted catgut sutures are carried, upon a fully curved needle, through all the coats of both margins, the highest stitch of this first tier being placed just below the upright tube, as seen in Fig. 3754, I. These stitches of the first row are tied. The second tier of interrupted sutures are of fine silk (or Pagenstecher – sometimes fine chromic gut) – and are sutures of the outer coats only (seromuscular), and do not penetrate the lumen nor include the margins. In Fig. 3755, II, all of these second-tier sutures are placed, and some are tied. The completed drainage is seen in Fig. 3756.



Figs. 3754 and 3755.—The Same – II–III; – I, The placing of the first tier of marginal catgut sutures through all the coats of the incision; – II, these tied – and the outer tier of non-penetrating, non-marginal, seromuscular sutures placed, ready to be tied.

In addition to the technic of suturing above described, other methods of closing the biliary ducts by suture have been already given. And the Kehr method of suturing ducts has been given in somewhat greater detail, in illustration and in the text, under drainage of the hepatic duct, following excision of the gall-bladder.

Robson's method of draining the common duct consists in introducing a

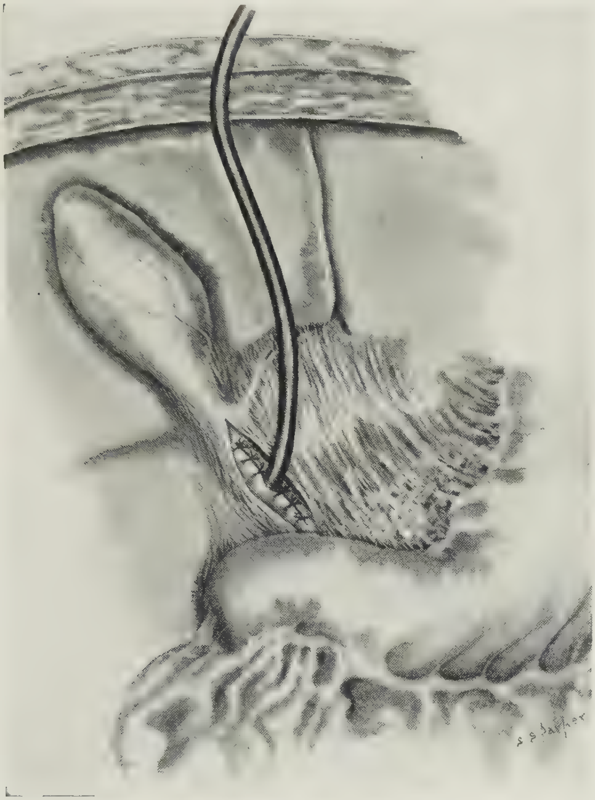
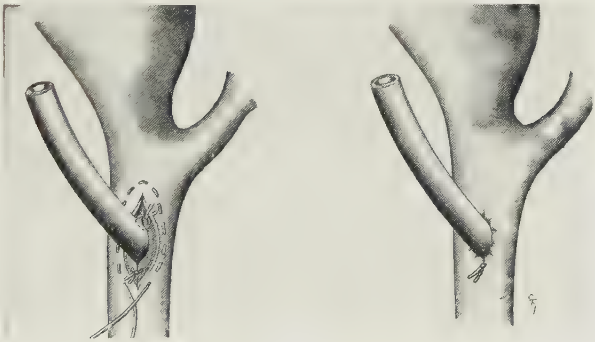


Fig. 3756.—The Same _ IV; _ The anchorage of the T-drain in the incised common duct completed _ and the outer end of the tube conducted out of the abdominal wound. The packing of gauze which will surround the rubber tube in its transit of the abdomen is not here shown.



Figs. 3757 and 3758.—Mayo Robson's Method of Direct Drainage of the Common Duct: _ a, The rubber tube is anchored to the margins of the deeper coat of the incised duct with a catgut stitch at the upper end of the incision _ the rest of the incision through the muscularis and mucosa is closed by through-and-through sutures; _ c, the peritoneal coat is gathered around the tube by means of a purse-string suture.

Jaque's No. 12 catheter into the duct wound _ being certain to see that its end passes upward toward the source of bile _ after which he anchors the tube by a single catgut stitch into the upper end of the duct wound – and then closes the margins of the mucosa and muscularis by through-and-through marginal sutures – following this by a purse-string suture of the peritoneal coat, which is thus made to snugly hug the tube at its site of entrance into the duct. The technic is shown in Figs. 3757 and 3758.

The tube anchored within the common duct is conducted out through the abdominal wound, and, in addition, drainage of the field of operation is instituted, to conduct away any leakage which may come from the site of drainage, as well as any peritoneal fluid infected by the manipulations near the site of operation. The latter drain is usually composed of gauze strips, or of gauze strips within rubber tissue, or of a split rubber tube containing strips of gauze. The peritoneal drain may be anchored in the deep recess near the common duct, with a single fine catgut suture. Both drains are usually freed within from five to ten days. The peritoneal drain may be then withdrawn entirely – but the common duct drain should be shortened gradually. The abdominal wound is closed up to the exit of the drains.

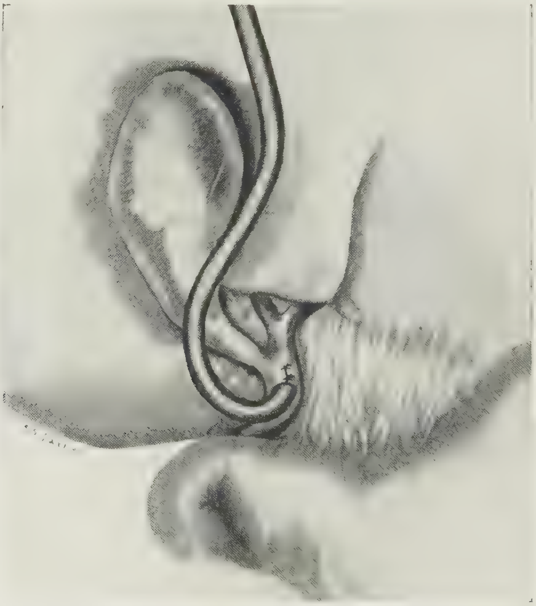


Fig 3759.—Draining of the Common Duct with an Ordinary Rubber Tube – with its inner end carried toward the liver for about 2.5 cm. (1 inch).

Comments.—If the gall-bladder is in such condition as to be serviceable for the purpose, it is preferable to close the common duct wound which may have been made for the extraction of stone, and drain the biliary tract through a cholecystostomy wound.

Routine drainage is the safest procedure after opening the common duct, as infective cholangitis is generally present.

After introducing an ordinary tube into the common duct it should be carried upward for about 2.5 cm. (1 inch) before it is anchored *in situ*.

In principle, it is held that sutures which close the different bile-ducts should not penetrate their lumina – and yet in the technic of the best Surgeons such penetration is noted. At any rate, any sutures which so penetrate should be of fine catgut, which are probably dissolved before having had time to form nuclei for stone formation.

The position of an ordinary type of rubber tube introduced through the incised common duct, toward the liver, is shown in Fig. 3759 - the tube pointing downward and outward as the liver is lowered.

RETRODUODENAL CHOLEDOCHOTOMY FOR CALCULUS FOLLOWED BY CHOLEDOCHORRHAPHY

HAASLER-KOCHER TECHNIC

Description.—The incision of the ductus choledochus behind the duodenum for the extraction of stone - followed by its suturing. The operation was introduced by Haasler in 1898 - and was popularized through the introduction of Kocher's method of mobilizing the duodenum. The operation is indicated in those cases where a calculus has become impacted within the retroduodenal part of the common duct or in the ampulla of Vater - and where, at the same time, the stone can neither be dislodged upward into the supraduodenal portion of the common duct nor downward into the duodenum. The procedure has become a recognized technic, although some good operators in this special field of Surgery declare that they have never encountered a

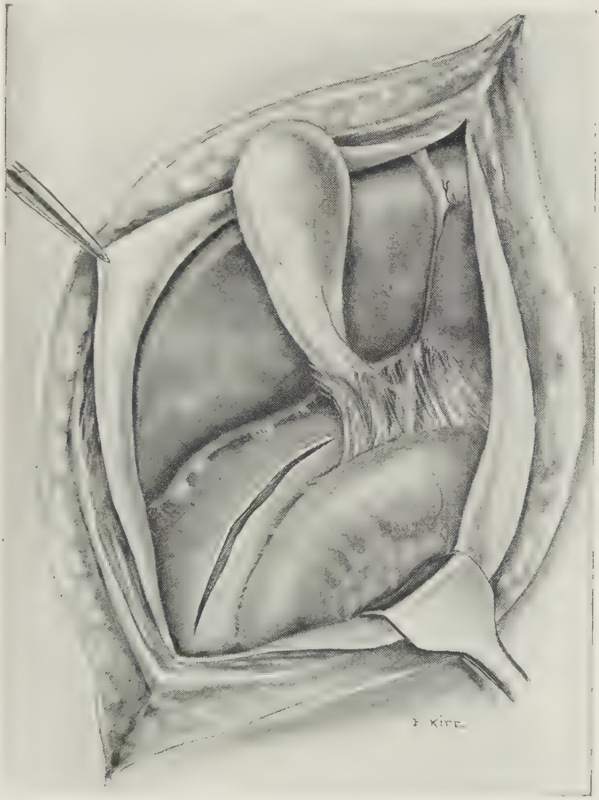


Fig. 3760.—Retroduodenal Choledochotomy for Calculus Followed by Choledochorrhaphy (Haasler-Kocher operation) - I; - Incising the parietal peritoneum over the right kidney. (Figs. 3760–3762 modified from Kehr.)

case where a calculus in this part of the common duct could not be pushed either proximally into the supraduodenal portion – or could not be reached by incising the papilla of Vater through the duodenum. In Figs. 3613 and 3720 are shown stones impacted in such a part of the retroduodenal portion of the common duct as to call for removal by retroduodenal choledochotomy.

Operation.—Having opened the abdomen, examined the field of operation, and traced down the bile-ducts from the liver and gall-bladder to the duodenum, the parietal peritoneum of the posterior abdominal wall is curvilinearly incised over the right kidney, the incision being approximately 2.5 cm. (1 inch) to the right of the duodenum, and paralleling its curve – but carried with especial care as it nears the course of the inferior vena cava (Fig. 3760). Then by blunt dissection with the fingers the parietal peritoneum is stripped up toward the median line until the duodenum is reached – encountering, as one often does, glands in the angle between the duodenum and common duct, and which may be removed. By gentle traction mediad the second portion of the duodenum is freed, drawn from its bed, and, together with the head of the pancreas, turned upon itself, toward the left, until its posterior aspect is exposed and looks almost directly forward (Fig. 3761). In the majority of cases the duct is found covered by the pancreas, when the

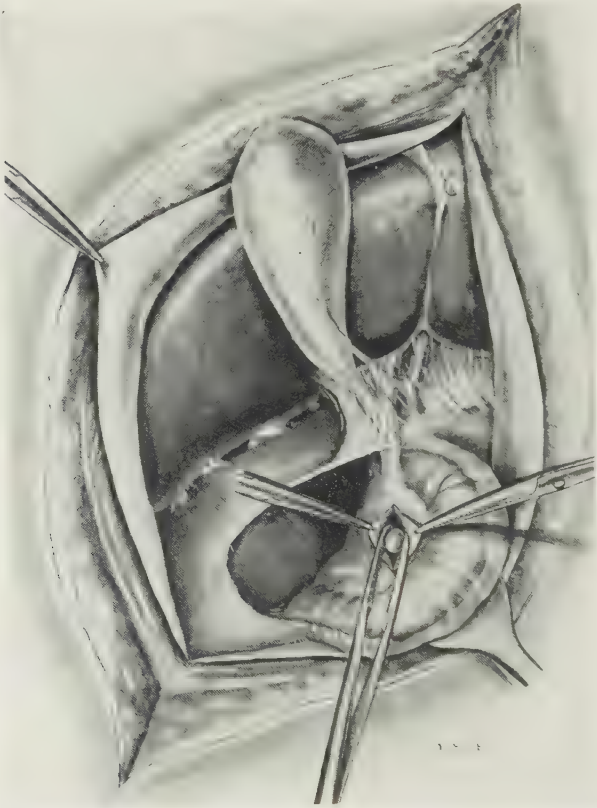


Fig. 3761.—The Same – II; – The mobilized "horseshoe" of the duodenum turned forward, exposing the retroduodenal portion of the common duct and the head of the pancreas. An incision has been made through the overlying pancreatic tissue into the common duct – followed by the extraction of the calculus.

duodenum is mobilized and turned over – while in some cases the common duct simply lies within a groove in the head of the pancreas. Where the duct is covered with pancreas, the position of the stone is determined by palpation (and its contour is often visible), the duct is steadied between two fingers, and an incision made directly through the substance of the overlying pancreas, and through the wall of the duct, down upon the contained stone. If the duct merely lies within a groove of pancreatic tissue the technic is correspondingly simpler. Or sometimes the partially enveloping pancreatic tissue can be pushed away from the duct by blunt dissection. As the pancreatic tissue in contact with the duct is usually fibrosed from localized pancreatitis, its division is not apt to be followed by much bleeding. Some Surgeons make the division of the overlying pancreas with the actual cautery. The stone is removed from the incised duct by forceps, after retracting the lips of the incised duct and overlying pancreas, just as described in the supraduodenal operation, and as shown in the illustration. After the stone has been removed, a thorough instrumental examination is made of the patulousness of the rest of the duct, upward toward the cystic duct, and downward to and through the opening into the duodenum. When the stone has been

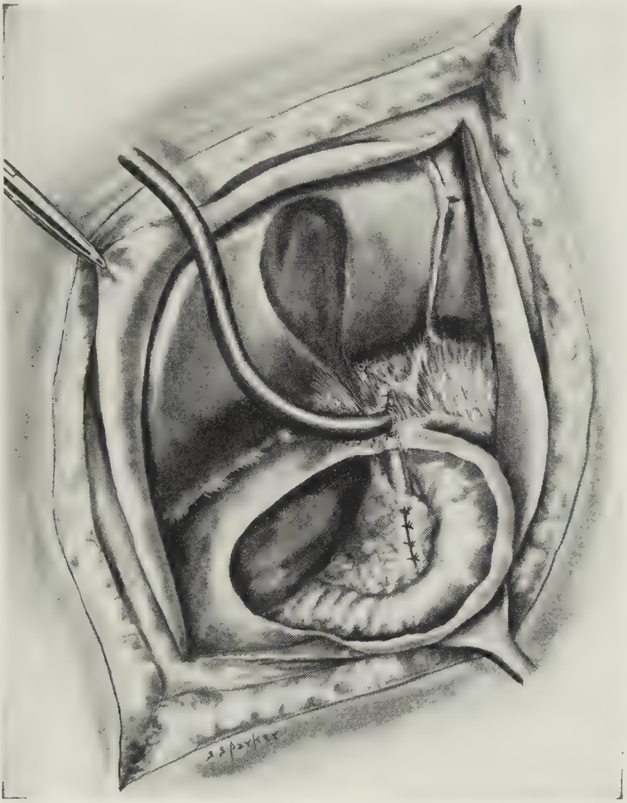


Fig. 3762.—The Same – III; – The incised common duct has been sutured – and the incised overlying pancreatic tissue has been separately sutured over the duct. In the case here pictured the supraduodenal portion of the common duct has been drained, to lessen tension upon the suturing of the lower, more dangerous site of suturing. The gall-bladder also is sometimes removed in cases of marked involvement.

removed and the patency of the tract established, the restoration of the parts is proceeded with. As this part of the common duct is not covered with peritoneum, its satisfactory closure is more difficult than is ordinarily the case. The incised duct is first sutured with fine chromic gut, the stitches passing through all of its coats except the mucosa _ and after this the pancreatic tissue is sutured over it with fine chromic catgut _ as shown in Fig. 3762. It is somteimes wiser to only close the common duct by suture and to temporarily drain the pancreatic wound. The incised parietal peritoneum is also sutured.

Or one may suture both the duct and the pancreatic wound, and then establish drainage of the supraduodenal portion of the common duct, as shown ni the illustration last quoted _ and in this way relieve the strain upon a part of the duct where leakage might be more disastrous, where its drainage would be more difficult, and where the duct, because of the absence of peritoneal covering cannot be so well protected in suturing.

The gall-badder itself is sometimes found to require removal in connection with the cases of supraduodenal choledochostomy.

In concluding the operation the mobilized duodenum is turned back into place, and the incised parietal peritoneum sutured. Drainage of the field of operation in retroduodenal choledochotomy is especially important _ apart from any drainage of the ducts.

Comments.—The common duct passes through the substance of the head of the pancreas in 62 per cent. of the cases according to some _ in 95 per cent. according to others.

Drainage of the retroperitoneal space is of especial importance in the retroduodenal operation _ and it is convenient to bring a cigar-drain, or a split rubber tube, with a core of gauze, through a stab wound in the loin, external to the right kidney _ the inner end going down as near to the sutured duct as possible.

Kocher stresses the importance of temporarily draining off the bile higher up by a supraduodenal choledochostomy to relieve the strain upon the retroduodenal choledochorrhaphy. The flow may be very excessive _ he reports, following a retroduodenal choledochotomy for calculus, the flow of bile and pancreatic fluid as amounting to 2800 c.c. (approximately 5 pints) daily. Kraske reported a somewhat similar case, where the patient died from excessive loss of these fluids.

Kehr and Kocher both agree that there are cases where, as a result of pericholedochitis, it is impossible to dislodge the stone from the retro- into the supraduodenal portion of the common duct.

If a retroduodenal stone cannot be dislodged and then removed, or removed by retroduodenal choledochotomy, then the only recourses are: choledocholithotripsy, duodenocholedochostomy _ or removal by transduodenal operation.

TRANSDUODENAL CHOLEDOCHODUODENOSTOMY FOR CALCULUS

KOCHER'S OPERATION

Description.—This procedure is resorted to for the purpose of removing an impacted calculus from the third, or interstitial portion of the common duct (which, from 12 to 19 mm., or $\frac{1}{2}$–$\frac{3}{4}$ inch in length, passes through the postero-internal wall of the second portion of the duodenum, from the end of the second part, to the ampulla of Vater). Such a calculus is shown in Fig. 3613, **b**. The operation necessitates cutting entirely through the anterior wall of the duodenum _ into but not through the posterior wall _ and through the inner wall of the interstitial part of the common duct. The duodenum is usually incised through its free, anterior aspect, rendered accessible by simple manipulation, when it is movable, and especially when the patient is thin and the liver is low – but in difficult cases, with an adherent duodenum and a stout patient, the second portion of the duodenum is generally mobilized and turned forward and inward, as described in retroduodenal choledochotomy, p. 587, and the incision of approach made through the anterior wall of the mobilized duodenum. The incision into the common duct, which begins as a transduodenal choledochotomy, is terminated as a choledochoduodenostomy – for the incision of the duct wall and the adjacent wall of the duodenum are so sutured as to form a fistulous communication.

Kocher recommends this procedure in cases where a large calculus is impacted in the lower portion of the common duct, but not at its very orifice, – where access from without is difficult, owing to adhesions, – where the stone is too firmly fixed in its position to be manipulated into some other more favorable position, – and where a probe cannot be passed in from the papilla, or the papilla cannot be readily located.

Operation.—The abdomen is opened, the liver lifted and rotated, and the biliary tract examined and packed off. The first step in the operation is to bring the descending portion of the duodenum into sufficient accessibility for the necessary manipulations – and the ability to do this will depend upon such conditions as mentioned above. Effort should be made to bring it forward by introducing two fingers behind it, or through the foramen of Winslow. Failing in this, it is best to mobilize the duodenum by incising the parietal peritoneum over the right kidney – the technic of mobilization having been described under retroduodenal choledochotomy, p. 587. (If this be done, the mobilizing incision of the peritoneum is sutured at the end of the operation.)

Whether by manipulation, or mobilization, therefore, the duodenum is displaced forward with its anterior wall presenting. The position of the calculus is determined by digital palpation through the unopened bowel. The stone is held steadily in one position, the intestinal flow controlled, as well as possible, by pressure by fingers or clamps, with ample provision to catch all intestinal outflow. An incision is now made through the anterior wall of the duodenum directly over the stone – most Surgeons cutting the intestine axially, and Kocher, transversely (as more anatomic). As soon as the duodenal fluids are mopped away, the interior of the intestine is examined and the position of the stone further determined, while the walls of the intestinal opening are retracted. The prominent bulge made by the stone is usually readily recognized a short distance above the ampulla (which is generally recognizable), and in the known line of the interstitial part of the common duct. At least an attempt should be made to displace the stone downward and to remove it through the ampulla. If this fails, an axial incision is at once made directly down over the stone (Fig. 3763) – and immediately following, and before any attempt is made to remove the stone, two fine chromic catgut sutures are carried through the center of the margins of the wound, and including all the tissues between the calculus and the duodenal mucosa. These stitches are tied, and then serve as tractors during the extraction of the stone. As soon as they are tied, if the original incision over the stone was not long enough, its length is increased – and the stone extracted with forceps or a scoop – after which stitches are similarly placed at the two angles of the wound – and as many more as considered indicated. These sutures are important in binding together the duodenal wall, duct wall, and possibly pancreatic tissue, for there is no certainty, especially above, as to whether the incision may not have opened the pancreatic tissue. The stitches, when tied, bring the mucosa of the common duct and of the duodenum into contact, forming the choledochoduodenostomy or choledochoduodenal fistula (Fig. 3764).

Before concluding the operation the common duct should be examined with a probe in both directions — or with the finger, which the duct is often large enough to admit — combined with external manipulation. Until after the examination is completed the tied sutures are left long as useful tractors — and then cut short. While only three stitches are usually introduced (above and on both sides of the fistulous opening), as many may be used as seem needed.

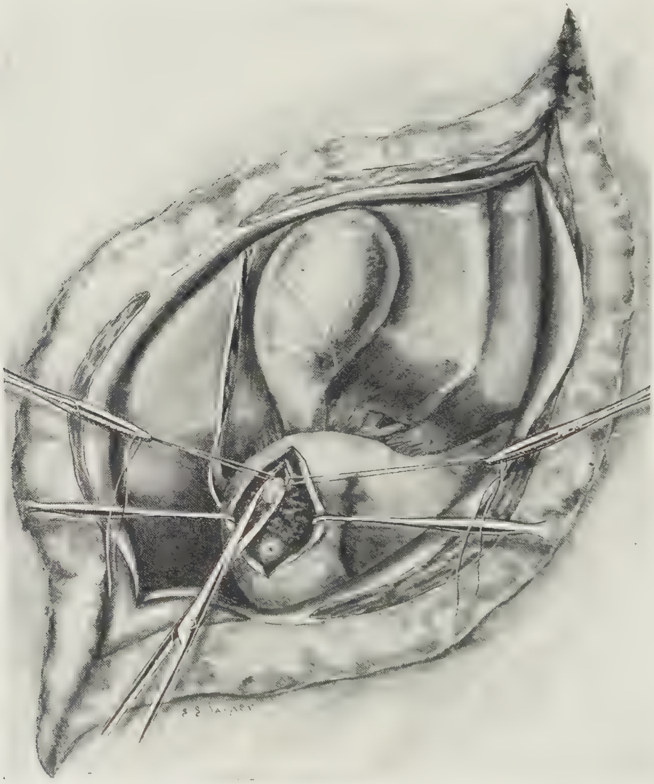


Fig. 3763.—Transduodenal Choledochoduodenostomy — I; — The second part of the duodenum has been displaced forward (whether by manipulation or mobilization) — its anterior wall incised and retracted — and an incision carried into (but not through) the postero-internal duodenal wall, and into the interstitial part of the common duct — exposing the calculus. Two catgut traction sutures have been placed through the margins of all the tissues between duodenal muscoa and stone, and tied. The stone is shown in the act of being removed with forceps. The opening of the duodenal ampulla is shown just below the incision for the stone.

The incision through the anterior wall of the duodenum is now closed by a first tier of catgut passing through the margins of all the coats — to be followed by a seromuscular tier of silk, or Pagenstecher — and the entire line of sutures may be reinforced by stitching the omentum, or an omental patch, over it. The majority of fatalities following this operation occur from leakage through the suture line.

The duodenum is finally allowed to resume its natural position – and if mobilization has been performed, the margins of incised parietal peritoneum are sutured together. In some instances it is indicated to also remove the gall-bladder – or to temporarily drain from the supraduodenal portion of the common duct, or both. In the performance of simple transduodenal choledochoduodenostomy drainage from the site of operation, the sutured duodenum, through the abdominal wound, is probably omitted by the majority in the absence of special indication. It is different when additional operations are simultaneously performed, as cholecystostomy, supraduodenal choledochostomy, or cholecystectomy.

Comments.—In operating upon strictly the third, or interstitial portion of the common duct, the incision passes only into, and should not pass all the way through the postero-internal wall of the duodenum – but for fear of overstepping the strict limits of the interstitial part of the duct, all the tissues cut through, down to the stone, should be at once clamped, or, better, sutured together, as above described, so as to block off any entrance of intestinal fluid into the parapancreatic, intrapancreatic, or peritoneal regions.

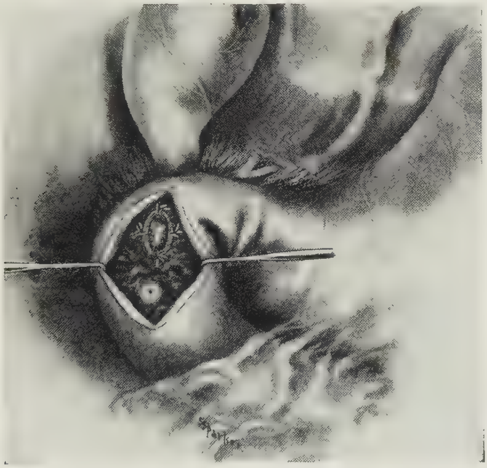


Fig. 3764.—The Same – II; – The choledochoduodenostal opening completed and sutured.

The incision into the postero-internal duodenal wall, over the stone, will be axial, oblique, or transverse, according to the shape and features of the special case.

The choledochoduodenostal opening should be planned amply large, against future repetition of the same condition – as any excess of opening will contract.

While one might expect complications from regurgitation of intestinal contents into the common duct, this has not been observed.

Some operators have omitted the suturing of the margins of the incised duodenum and common duct, upon the basis that all of the cut surfaces were interstitial – and while, theoretically, this may be warrantable, practically it is safer to safeguard the site with stitches, as described above.

Naturally, if a stone in the interstitial part of the duct can be manipulated into the ampulla, the operation about to be described would be preferable to the above procedure – but this is rarely possible.

TRANSDUODENAL AMPULLARY CHOLEDOCHOTOMY FOR CALCULUS

McBURNEY'S OPERATION

Description.—This procedure, also termed "ampullary choledochotomy," "transduodenal choledocholithotomy," and "duodenocholedochotomy," consists in the removal of a stone lodged within the ampulla of Vater, by approaching it through an incision in the anterior wall of the descending duodenum, and then axially incising the upper margin of the ampulla. The mouth of the ampulla may sometimes be dilated with small forceps, and the stone removed with or without cutting. Such a calculus is shown in Fig. 3765.

The operation has much in common with transduodenal choledochoduodenostomy, just described – the two sites of operation lying within less than 2.5 cm. (1 inch) of each other. And what is there said as to exposure of the duodenum by manipulation or mobilization applies here.

The operation is indicated where a stone is impacted in the ampullary opening of the common duct.

Operation.—Up to the point of making the incision directly over the stone, after opening the intestine, the steps of the operation are all exactly the same, in every detail, as described in transduodenal choledochoduodenostomy, except that the incision through the anterior wall of the duodenum is made a little lower. When the duodenum is exposed, an attempt is first made to bring its anterior wall into convenient relationship for incision, but if it be found deeply placed and otherwise difficult to expose, it should be mobilized by incising the parietal peritoneum over the right kidney, as described under Retroduodenal Choledochotomy, p. 587. By whatever process resorted to, the descending colon is brought sufficiently into the field for the necessary steps. Provision is made by digital control, or clamping, together with gauze packing, to catch any leakage from the intestinal canal. The calculus within the ampulla is seized with the Surgeon's left forefinger and thumb and brought up against the anterior wall of the duodenum – and, while thus held, an incision is made through the anterior duodenal wall directly over the stone. Another method consists in hooking the duodenum and, with it, the lower end of the common duct, forward with the left middle finger, while the left forefinger and thumb compress the duodenum proximally, to control its flow.

As soon as the anterior wall of the duodenum is incised, and the outflow caught, the ampullary opening is located, which is generally readily done, through the sensation of the nearby stone, imparted to the finger. If the size and nature of the stone and its surroundings are encouraging to that end, an effort should first be made to dilate the orifice of the ampulla with thin-bladed forceps – and to then withdraw the stone by the act of closing these blades which were at first used as dilators. Failing in this, an incision is made about 1 cm. (6/16 inch) in length, beginning above and extending down through the upper circumference of Vater's ampulla (Fig. 3765) – which lies about 3 cm. ($1\frac{3}{16}$ inches) below the angle representing the junction of the first and second portions of the duodenum, and at the junction of the internal and posterior walls of the duodenum. The incision does not pass through the lower circumference of the ampulla. The stone may at once fall out into the duodenum, but generally has to be either drawn out with forceps (Fig. 3766) or pressed out by passing an instrument behind it. Flow of bile immediately follows, and should be prepared for.

The lumen of the common duct is then examined with a probe to ascertain its freedom from other stones. It sometimes happens that on opening the abdomen, an incision had first been made into the supraduodenal part of the common duct, and that failing to remove a stone through the incision, either a transduodenal choledochoduodenostomy, or this transduodenal choledochotomy is undertaken. If this be the case, when the lower opening is made, Kehr has suggested drawing a piece of gauze (hemmed, so as to have no ravelings), threaded upon an eyed probe, or in the grasp of forceps, through the supraduodenal choledochotomy wound, out through the transduodenal choledochotomy wound – as seen in Fig. 3767 – for the purpose of removing all possible calculi and sand from the common duct between the openings.

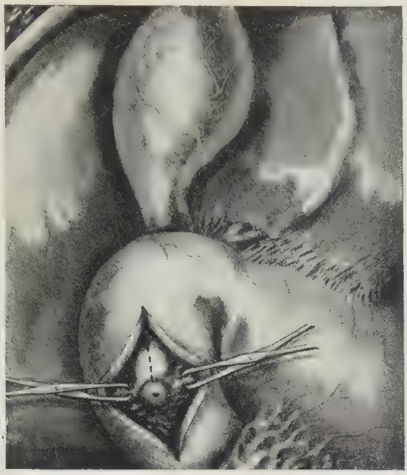


Fig. 3765.—Transduodenal Choledochotomy for Calculus Impacted in the Ampulla – I; – The anterior wall of the second portion of the duodenum has been incised, the margins of the wound retracted, and the duodenal mucosa, on each side of the ampullary stone, steadied with tenaculum forceps, or thread tractor sutures preparatorily to incising the upper lip of the ampulla and the inner wall of the mouth of the duct in the dotted line.

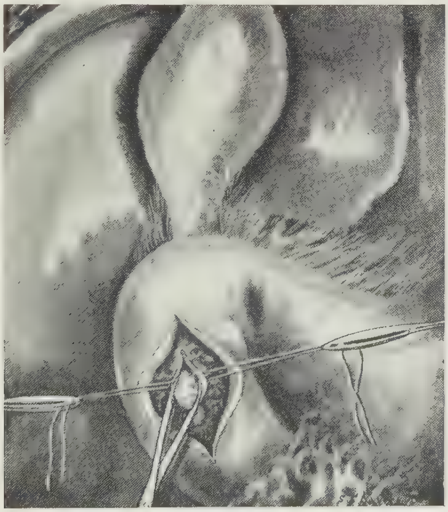


Fig. 3766.—The Same – II; – The incision directly down upon the stone, into but not across the orifice of the ampulla – and the two catgut sutures, first used as tractors while the stone is being extracted with forceps.

In concluding the operation it is not necessary to suture the lips of a short incision into the duct, but if the incision have been made of any considerable length, the upper portion of it should be brought together by fine catgut sutures, thus restoring that part of the common duct. It might, generally, be safer to put in one or two sutures at the upper limit of the incision into the duct, in all cases. The incision through the anterior wall of the duodenum is closed, first, by a through-and-through tier of catgut sutures through the margins of the cut, followed by silk or linen seromuscular Lemberts. If much soiling of the cavity have occurred, and in any doubtful case, temporary abdominal drainage should be carried down to the site of the outer duodenal wound. If the duodenum has been mobilized, the incised peritoneum is sutured back into place – and it may be indicated to drain the right kidney pouch.

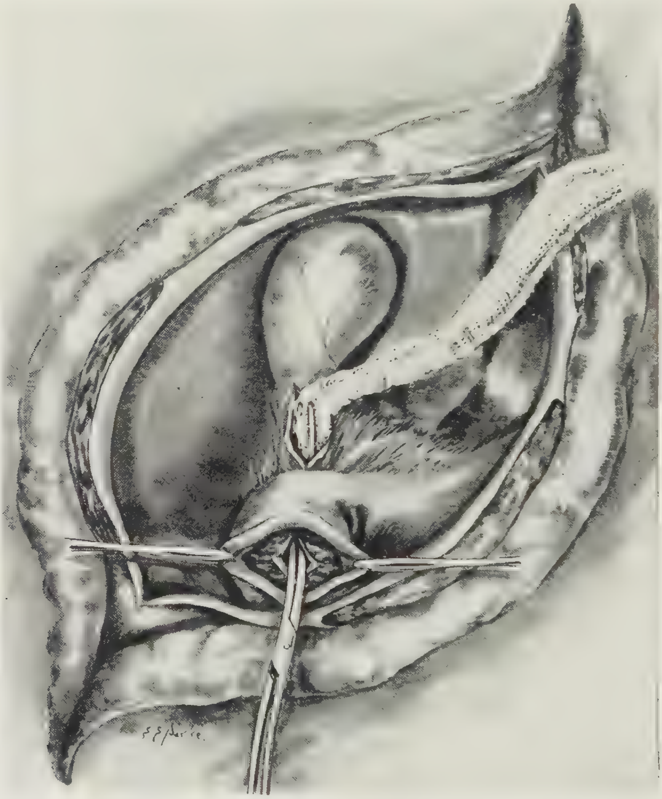


Fig. 3767.—The Same; – Illustrating Kehr's method of removing calculous collections from the common duct – in those cases where a supraduodenal incision into the common duct may have been made in the course of operation in conjunction with the transduodenal incision of the ampullary end of the duct – by the traction of a strip of gauze from the upper through the lower opening, several times repeated.

Comments.—While some operators leave the incised ampulla as it is, it is better, as soon as the incision over the stone is made, and before its removal, to place two catgut sutures laterally, which will first serve as tractors, and will then be tied – for in this way the ampulla is subsequently kept more patulous and is less apt to incarcerate a stone.

CHOLEDOCHODUODENOSTOMY BY LATERAL ANASTOMOSIS

Description.—When some type of obstruction exists in the distal end of the common duct, which, from its nature, or from the conditions of the surrounding parts, cannot be removed by operation, the flow of bile may sometimes be short-circuited into the duodenum without severing the duct — constituting lateral choledochoduodenostomy. In those cases where free mobility of the parts exist and especially when the common duct is very considerably enlarged by the abnormal distention, this anastomosis may be accomplishable without operative mobilization of the duodenum. When, however, this is not the case, the duodenum should be mobilized in the same manner as described for the operation of retroduodenal choledochotomy (p. 587) — and the incised parietal peritoneum be resutured at the end of the operation. When thus mobilized, the duodenum can be displaced forward and upward sufficiently for the anastomosis. The site of anastomosis is between the supraduodenal portion of the common duct and the adjacent free surface of the first portion of the duodenum.

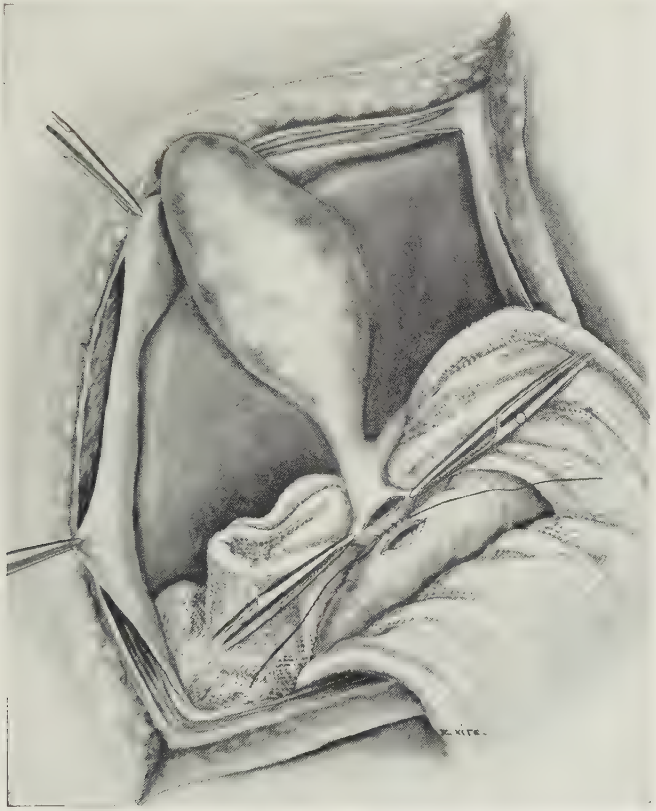


Fig. 3768.—Choledochoduodenostomy by Lateral Anastomosis — I: — The approximation of the common duct and the first part of the duodenum — and the placing of the posterior tier of seromuscular silk sutures just back of and parallel with the lines along which the duct and bowel are incised.

Sometimes the duodenum cannot be utilized because of extensive adhesions or other reasons — and then the anastomosis may be made between the common duct and the loop of jejunum, some 51 cm. (20 inches) below the duodenojejunal junction, followed by a jejunojejunostomy, several inches still lower. This procedure, however, is less desirable than choledochoduodenostomy.

Operation.—After opening the abdomen, examining and protecting the parts, the sites of the common duct and the duodenum to be anastomosed are brought together, either by manual manipulation or operative mobilization, as described in the above paragraphs. If the opposite structures can be so clamped as to bring them into easy relationship for the operative technic, and prevent the escape of intestinal contents, this is most desirable, (clamps are omitted from the illustrations of the operation for the sake of clearness). Otherwise, they are held in relationship digitally, or by forceps, or by thread tractors. A posterior line of seromuscular sutures of silk or linen is placed just back of the site to be incised in both structures (Fig. 3768). Parallel incisions, which will cross the common duct transversely, and the duodenum, axially, are then made through all the coats and into the lumina of duct and bowel. If the bile flow is not otherwise controlled, a piece of gauze is sometimes pushed up the duct to temporarily control the flow. A posterior marginal row of five catgut sutures is then carried through all the coats (Fig. 3769). After which the marginal row of catgut sutures is continued around the anterior borders of the opening, and then the seromuscular silk line is also continued around the anterior aspect of the opening, the completed anastomosis appearing as shown in Fig 3770. Finally, the site of operation is cleansed, and the abdomen closed, with or without drainage, as may seem indicated.

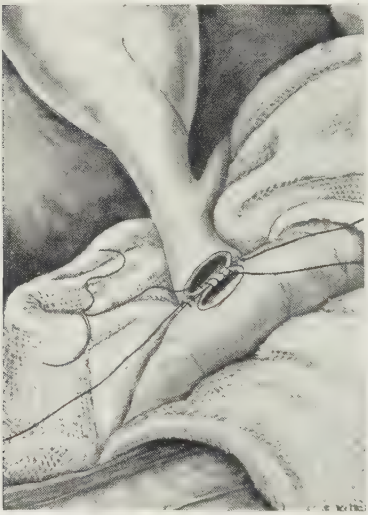


Fig. 3769.—The Same, II; The incisions into the lumina have been made, and the posterior marginal catgut sutures are being placed.

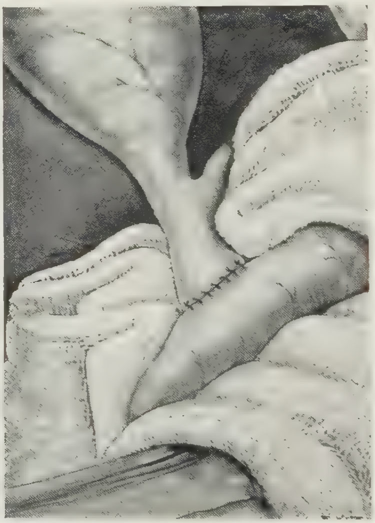


Fig. 3770.—The Same, III; The completed anastomosis.

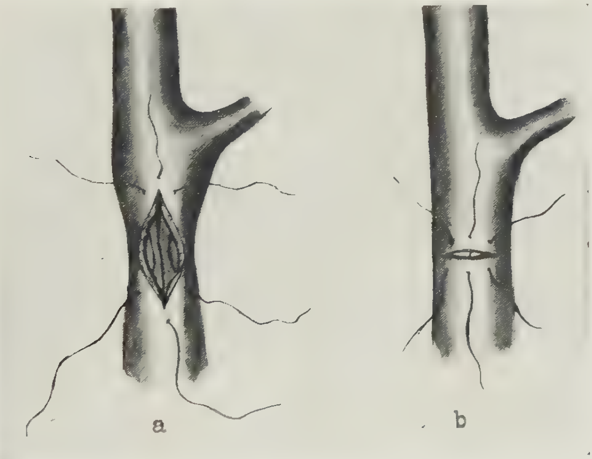
CHOLEDOCHODUODENOSTOMY BY END-IN-SIDE IMPLANTATION FOLLOWING CHOLEDOCHOTOMY OR PARTIAL CHOLEDOCHECTOMY

Description.—As an alternative form of choledochoduodenostomy, there may be involvements of the common duct which call for its division, or for an excision of part of its course, such as stricture, tumor, calculous impaction, and degeneration of its wall – where it is possible to adopt the above technic – of closing the distal end of the divided or excised common duct, and implanting the proximal end into the duodenum.

Of this method William J. Mayo writes: – "This method has been used in our Clinic several times, following resection of the common duct for cancer, and once following partial gastrectomy for cancer of the pyloric end of the stomach. After removing the involved portion of the common duct the distal end is tied, the stump covered with peritoneum – and the proximal end united to the duodenum after the method of Coffey. This method is applicable in primary operations when the liver end of the duct is easily accessible; in secondary operations there are, as a rule, so many adhesions that the duct cannot be sufficiently mobilized to accomplish it. Our experience in resections of the common duct for cancer in restoration of the biliary channel by any method has been discouraging. Two of these patients died soon after operation, and those who recovered lived less than eighteen months; in none of them, however, was death directly associated with this particular feature of the operation."

REPAIR OF WOUNDS OF THE DUCTUS CHOLEDOCHUS

Wounds of the common duct are generally either incised, such as are very apt to occur during an operation in this region, or, exceptionally, from stabs – or penetrating, or lacerating, as usually follow from gunshot, resulting, as a rule, in more or less destruction of the duct.



Figs. 3771 and 3772.—Plastic Enlargement of a Narrowed Duct – or the Sutured Repair of a Normally Narrow Common Duct, Wounded in Operation, Where Transverse Suturing Might Make the Lumen Too Small: – **a**, Two of the sutures are placed transversely, but are to be tied axially, while the midsuture is both placed and tied axially; – **b**, the sutures about to be tied.

Satisfactory exposure of the field is of primary importance – as shown in Fig. 3753.

The method of dealing with the chief varieties of these wounds will be briefly considered: –

Repair of Incised Axial Wounds of the Common Duct.—An average incised wound of the choledochus, such as is likely to occur while operating in this vicinity, may be treated in one of two ways: – If the duct be of such size that its caliber will not be harmfully narrowed thereby, the lips of the wound may be first brought together by marginal through-and-through sutures of all the coats, with fine catgut, passed transversely to the direction of the duct – followed by seromuscular sutures of reinforcement. The method is shown in Fig. 3771, **a.** If, however, it would seem that the duct will be too much constricted by this method of suturing, the same through-and-through marginal layer of fine catgut sutures, and outlying layer of seromuscular silk or linen sutures should be applied – but should be inserted in the opposite direction – that is, parallel with the direction of the duct – and as shown in Fig. 3772, **b** – and, when these are tied, the duct will, at least temporarily, be of even greater caliber than usual at the site of suturing.

Repair of Partial or Complete Incised Transverse Division of the Common Duct Without Loss of Substance.—In cases of clean-cut transverse wounds, partial or complete, an attempt should be made to restore the continuity of the duct by suturing with or without the aid of artificial device, as a support during suturing. In the event of a partial transverse division of the duct, a convenient method of using a temporary supporting form, is to select a short length (about 2.5 cm., or 1 inch) of rubber tube, of appropriate size – pass a piece of silk through one end of it, with a needle, thereby forming a loop by which to insert and withdraw it. This is carried, with the aid of two pairs of fine forceps (one manipulating the tube, one the margins), into the lumen of the wounded duct (Fig. 3773) – and over this the sutures are placed — a through-and-through tier of fine catgut, through all the coats of the margins of the wound – followed by a silk or linen tier of outlying seromuscular sutures. All are placed before any are tied, and then the rubber form is withdrawn – after which first the marginal tier, and then the outlying tier are tied. During suturing the parts are conveniently manipulated by

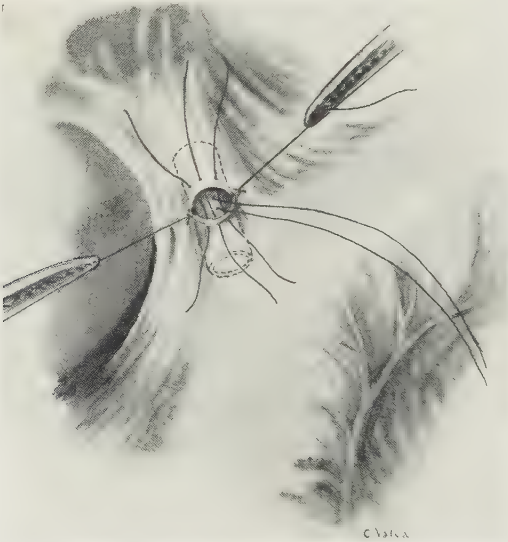
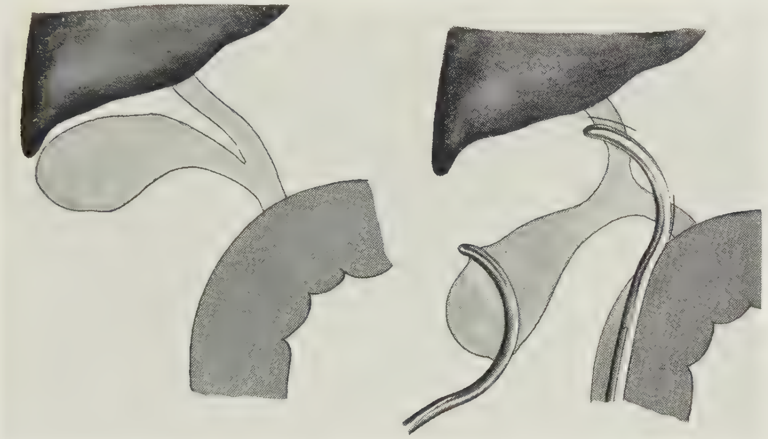


Fig. 3773.—Repair of Partial Transverse Division of the Common Duct by Suturing Over a Form; – A threaded piece of rubber tubing is temporarily carried within the lumen of the duct ends – over which, first, the through-and-through marginal catgut sutures are placed – and also the reinforcing seromuscular silk or linen sutures (the latter not here shown) – after which the form is withdrawn and the sutures tied.

grasping the part to be presented to the needle with forceps. Halsted's hammer is also used for this purpose, as explained at p. 578.

Where a complete incised transverse division of the duct has occurred, either without the loss of substance or with the loss of some substance, but not enough to prevent the approximation of the free, clean-cut ends, one has the choice of trying to unite the free ends by circular suture without drainage _ or to unite these ends throughout most of their circumference, and then institute T-drainage through the left opened portion. Kehr lays stress upon the number of cases in which the ducts have, undoubtedly, been wounded during operation. In Figs. 3774 and 3775 are shown how a part of both the hepatic and common ducts may be accidentally divided and partially excised _ as explained in the legends.

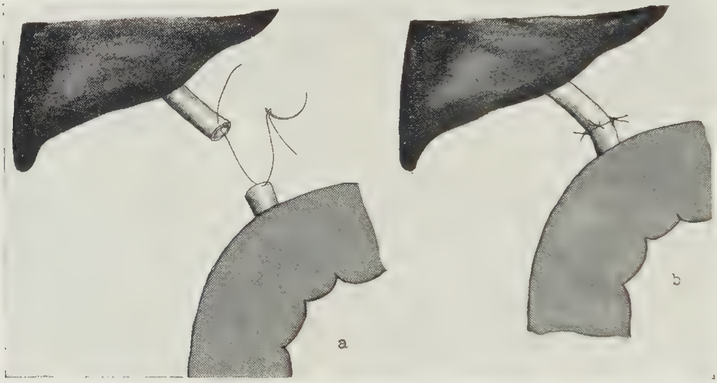
Union of the divided ends of the ducts which are capable of being brought into easy approximation have been successfully accomplished by simple circular suturing _ but this is not easy to accomplish with safety against leakage owing, chiefly, to both the technical difficulty of placing the posterior tier of even the through-and-through stitches of the margins, and to the absence of available (or manipulatable) peritoneal covering to the posterior wall of the duct, and the difficulty or impossibility of placing reinforcing sutures of a nature corresponding with ordinary seromuscular sutures. Such union, however, has been satisfactorily accomplished. One may at least undertake it, and, if, in its progress, it proves unsatisfactory, then change to the alternative mentioned below. Several fine chromic catgut sutures are carried through all the coats of both margins of the free ends of the ducts upon small fully curved needles _ as many of them as possible being so placed that the knots will lie outside of the lumen _ but in the case of the most posterior, this may be impossible, in which case they will be placed so as to be tied from within. The method of placing these stitches is seen, diagrammatically, in Fig. 3776, **a.** These sutures are now drawn together and tied _ as shown in Fig. 3777, **b.** The placing of the second, or reinforcing tier of silk or linen



Figs. 3774 and 3775.—REPAIR OF COMPLETE TRANSVERSE DIVISION OF THE COMMON DUCT BY SIMPLE SUTURING _ I and II: _ A, The normal relations of the gall-bladder, and the junction of the cystic, hepatic, and common ducts; _ B, showing the way in which, after freeing the gall-bladder, and drawing upon the latter, preparatorily to dividing the cystic duct, a curved clamp may also grasp the displaced hepatic and common ducts, so that portions of these may also be accidentally excised unintentionally.

sutures is atypical _ one managing, on general surgical ground, as well as they can with available tissues. And it is just in such cases that there may be unexpected adjacent tissues available _ in the form of bands of adhesion. These are sometimes made use of for holding reinforcing sutures posteriorly, corresponding, in type, with seromuscular sutures _ which, indeed, are sometimes placed before the marginal sutures. In front, the reinforcing sutures are of the seromuscular form, and of silk or linen. If the Surgeon be dissatisfied with the mechanical result of his joining, he should unhesitatingly abandon the plan of simple circular suturing without drainage and institute the combination of drainage, as explained below.

In other cases, from the first, it is decided to adopt a combination of partial circular suturing, or of circular suturing combined with T-drainage _ which, undoubtedly, is the safer method. In this event, the technic becomes exactly the same as that already described and pictured under partial choledochectomy, and excision of the hepaticocysticocholedocic junction (together with the gall-bladder), followed by circular suturing and T-drainage, p. 583.



Figs. 3776 and 3777.—The Same _ III and IV: _ **a,** The method of placing the marginal catgut through-and-through sutures _ as many as possible, so as to be tied on the outer side; _ **b,** the marginal sutures are tied, approximating the ends of the ducts, and the reinforcing seromuscular sutures, or their equivalents, are placed.

Comments.—In all of these difficult types of suturing use is made of omental grafting to reinforce the suture line wherever this is possible.

PLASTIC REPAIR OF DEFECTS AND GAPS IN THE HEPATICOCHOLEDOCHUS FROM THE STOMACH WALL

PROPOSED BY KEHR

Kehr has proposed a method for the repair of major defects of the hepaticus and choledochus (the first to be described, not yet having been put into use upon the living) _ but which seem practicable and worthy of trial.

Such a gap may be supposed to exist as would follow the excision of the gall-bladder, and of the junction of the cystic, hepatic, and common ducts _ leaving a considerable gap between the lower end of the hepatic and the upper end of the common duct.

The proximal end of the common duct is closed by suture _ and not further used.

A flap consisting of serosa and muscularis is raised from the anterior stomach wall from 2 to 3 cm. (13/16–1$\frac{3}{16}$ inches) broad, by 10 cm. (4 inches) long _ the pedicle of the flap overlying the pylorus _ and its free end reaching the middle of the stomach, between the greater and lesser curvatures. The stomach is carefully guarded against being accidentally opened.

A small opening is made into the stomach directly above the pylorus, transversely to the axis of the pylorus, just large enough to accommodate a 5 mm. (3/16 inch) rubber tube, of about 20 cm. (8 inches) in length. About 5 cm. (2 inches) of this tube is pushed through the opening into the duodenum, being anchored in the lip of the wound by a catgut suture. The effect of a Witzel canal is secured by doubling the flap from the stomach wall around the rubber tube, with the raw surface outside, and suturing the borders where they meet, thus constituting a tube of tissue around the tube of rubber. The canal thus formed must be amply long to meet the hepatic duct (Fig. 3778).

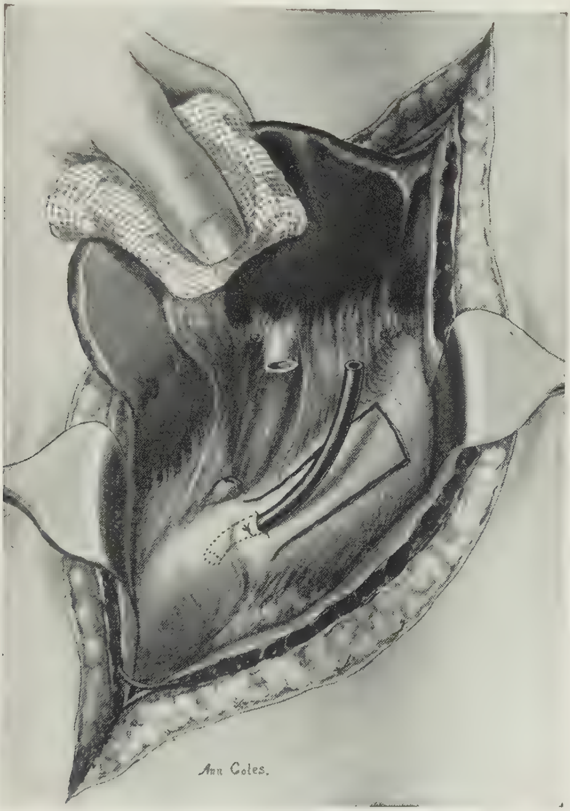


Fig. 3778.—Plastic Repair of a Gap Between the Hepaticus and Choledochus Following Excision of the Gall-bladder and the Junction of the Three Ducts by a Flap from the Anterior Stomach Wall _ I; _ The excision has been completed _ the end of the common duct sutured and dropped _ the rubber tube inserted through the pylorus into the duodenum _ and the flap of the gastric serosa and muscularis marked out. (For details see text.)

The protruding end of the rubber tube is inserted within the end of the hepatic duct _ after which the end of the hepaticus and the end of the tube

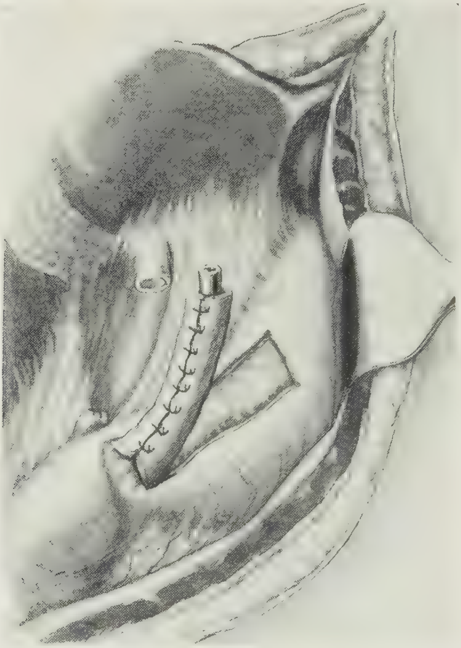


Fig. 3779.—The Same – II; – The seromuscular flap from the stomach wall has been raised and turned backward around the rubber tube, the raw surface outward, and sutured.

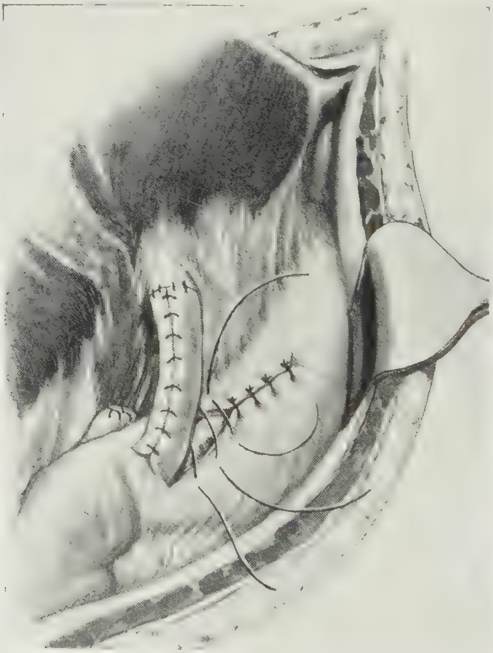


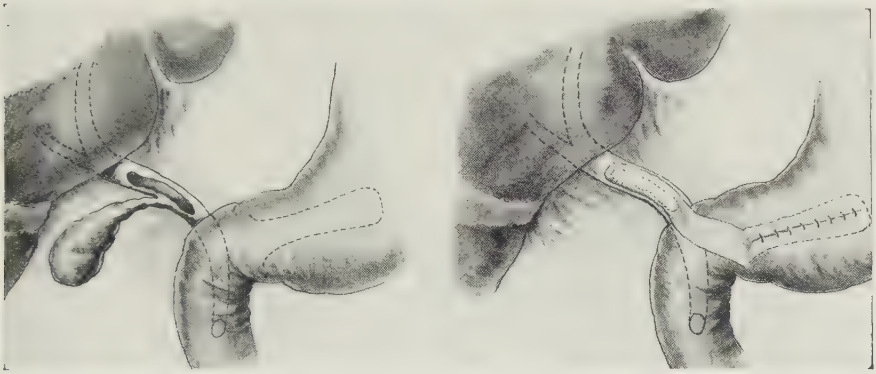
Fig. 3780.—The Same – III; – The junction of the hepatic duct and the artificial tube is sutured – the raw bed upon the stomach wall is being closed by approximation of the borders of the outer coats by means of seromuscular sutures – and the linear and circular suturing is about to be reinforced with omental grafts.

made from the stomach wall are sutured together, over the inner rubber tube _ which subsequently slips into the duodenum, after absorption of the anchoring stitch (Fig. 3779).

The linear and the circular suturing of the tube and the site of anastomosis is everywhere reinforced by omental grafts, against leakage. The bed from which the stomach flap is raised is so sutured, that the adjacent borders of serosa and muscularis are united over the raw surface (Fig. 3780).

The site of this extensive operation would be temporarily drained through the abdominal wound.

In the case of marked defect of the common duct, without severance, found at a secondary operation (Fig. 3781), Kehr raised a somewhat similar flap of serosa and muscularis from the anterior wall of the stomach _ turned it upward and backward _ and sutured it over the defect _ serosa to serosa (Fig. 3782) _ after which he brought together the margins of the defect left upon the stomach wall. The patient contracted pneumonia and died on the seventh day. The autopsy showed the transplanted flap everywhere adherent, and no technical defect in the operative procedure.



Figs. 3781 and 3782.—Closure of a Large Defect in the Hepaticocholedochus after Removing the Gall-bladder by a Seromuscular Flap Raised from the Anterior Wall of the Stomach; _ I and II: _ **a,** The defect in the hepaticocholedochus is shown _ and the outline of the planned seromuscular stomach-flap; _ **b,** the flap has been raised, turned backward upon its pedicle, and sutured over the defect, serosa to serosa.

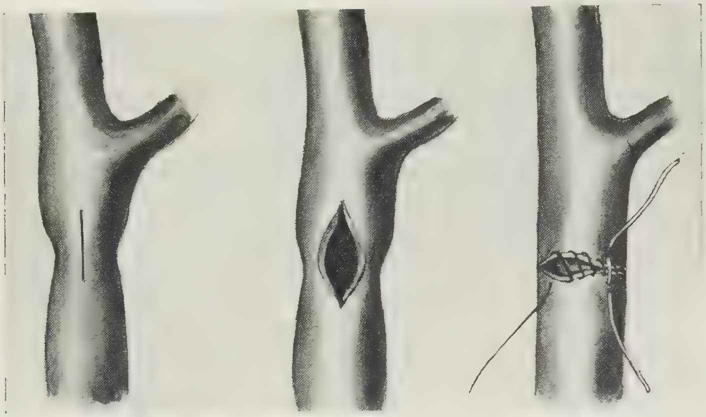
PLASTIC OPERATION FOR STRICTURE OF THE COMMON DUCT

Choledochoplasty, upon the principle of Mikulicz's pyloroplasty, has been successfully performed upon the common and cystic ducts in cases of stricture.

The stricture is incised throughout its entire length, in the long axis of the duct, and through the entire thickness of its wall. The duct is then put under traction, laterally _ so as to convert an axial into a transverse wound, in appearance _ after which the upper half of the wound is sutured to the lower half _ thereby gaining considerably in width at the site of former constriction.

Two tiers of sutures are used _ the inner, of catgut, and passing through all the coats of the margins, _ the outer, seromuscular sutures through the outer coats, of the Lembert type, and of silk, or linen.

The technic is illustrated in Figs. 3783–3785.



Figs. 3783–3785.—Plastic Operation for Stricture of the Common Duct: **a**, The constricted duct with a line over the site of incision; **b**, the incision completed, the duct showing some widening; **c**, the margins of the incision sutured transversely by a through-and-through catgut suture. One of the reinforcing seromuscular sutures is placed, ready for tying.

CHOLEDOCHOLITHOTRIPSY

The crushing of a stone within the common duct, with the passage of the fragments down the natural ways. The method has found practical application in some cases where, owing to dense, extensive adhesions, the common duct could not be exposed for incision and extraction of the stone. The technic adopted is the same as that for cholecystolithotrity, p. 556.

Theoretically, choledocholithotripsy or choledocholithotrity exposes to damage of the common duct in the act of crushing, or by the fragments in their downward passage, as well as to the retention of fragments as nuclei of future larger stones, but, nevertheless, has been successfully employed.

PARTIAL CHOLEDOCHECTOMY AND EXCISION OF THE HEPATICO-CYSTICO-CHOLEDICIC JUNCTION (TOGETHER WITH THE GALL-BLADDER), FOLLOWED BY CIRCULAR SUTURING AND T-DRAINAGE

Description.—Conditions occur which sometimes destroy the usefulness of a limited portion of the common duct, such as tumor growth, stricture, gall-stone obstruction, and the like, in which the diseased part of the duct has been excised, and the proximal and distal ends successfully anastomosed. The remaining ends have been brought together directly by sutures, without drainage, either of the ducts or of the abdomen, with entire success. But the method usually adopted has been to unite the two ends by suture everywhere except at the site between them through which a rubber drainage-tube is introduced. Again, the ends have been entirely united by suture, and the gall-bladder anastomosed with the duodenum, thus constituting two bile-routes. In the case of malignancy, cases have been so helped by the procedure that it is proved how much might be hoped for if the discovery of the growth were made when its involvement was very limited.

Operation.—In a case reported by Kehr carcinoma involved the common junction of the hepatic, cystic, and common ducts, in which the gall-bladder was excised, along with the cystic duct, and as much of the hepaticus and choledochus as indicated by the dotted lines (Fig. 3786). The gall-bladder has been excised, and is being drawn upon by its clamped fundus. The cystic artery is tied and divided. In the steps of dividing the ducts the outflow of bile and the possible dissemination of cancer products in such cases may be avoided by the application of clamps (lightly applied to the parts to be further used), besides the protection of the field with gauze pads. The hepatic duct may be clamped proximally to the site of section _ the common duct, between the growth and the level of division _ and a third, either on the cystic duct or between the growth and the line of section of the hepatic duct. Most of these clamps have been omitted from the pictures for the sake of clearness. The common duct is first freed and divided _ using unusual care to safeguard the vena portæ, which lies immediately behind and

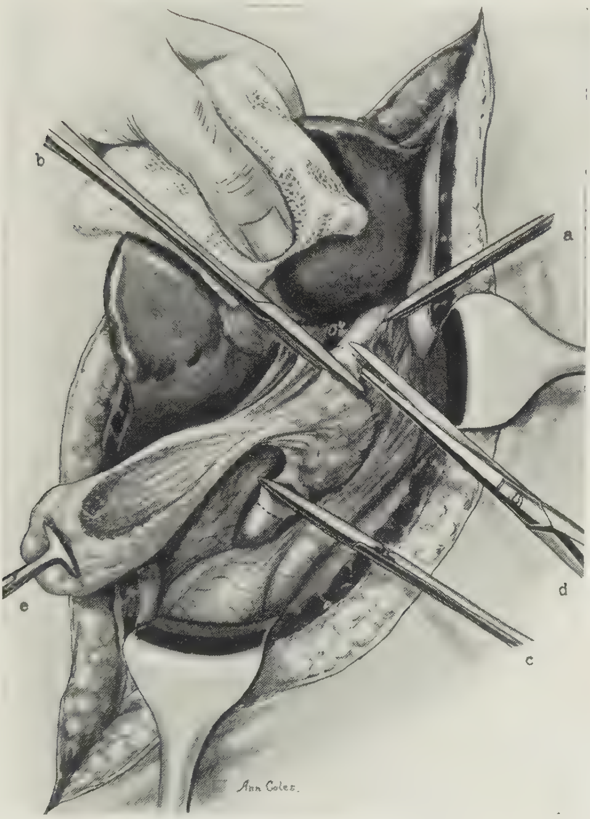


Fig. 3786.—Partial Choledochectomy _ Including Excision of the Hepaticocholedicic Junction, Together with the Gall-bladder _ Followed by Circular Suturing and T-drainage; _ The malignant involvement of the junction is seen _ and the levels at which the hepaticus (steadied by the clamp, **a**) and choledochus will be divided, distally to the upper clamp, **b**, **d**, and proximally to the lower clamp, **c**, are shown. The gall-bladder, **e**, has been removed from its bed. The cystic artery has been tied and divided _ as it passes forward behind the hepaticus.

to the inner side of it _ and the hepatic artery, a little further inward. The forceps which had previously clamped this then proceeds to roll it upward upon itself. The common duct and the gall-bladder both being drawn upon by their clamps, keep the hepatic duct under gentle tension while it is being carefully freed for division _ and in the act of making the section of the hepaticus, the cystic artery, proximal to its site of ligation, must be guarded, as it passes outward right behind the hepatic duct. The division of the hepaticus frees the involved structures, which are then removed.

Both ends of the divided ducts are now approximated by clamps carefully applied in such a way as not to traumatize them and jeopardize their vitality, and, at the same time, to so hold them in approximation so as to enable their free margins to be sutured and the drain inserted. Three catgut sutures are now carried through all the coats of the posterior margins _ entering the posterior wall of the hepaticus from within and passing out-

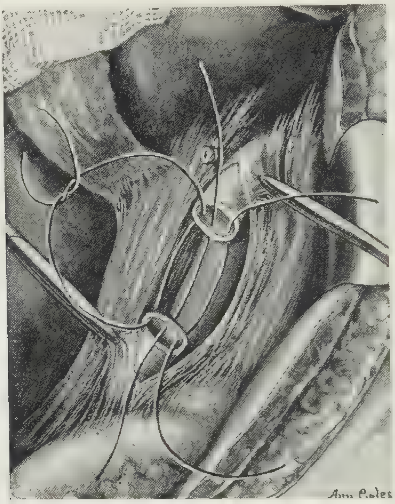


Fig. 3787.—The Same _ III; _ Three sutures of catgut are being passed from within outward, and from without inward, through all the coats of the posterior margins of the two ducts _ while the ends of the ducts are being approximated by forceps. (Redrawn from Kehr.)

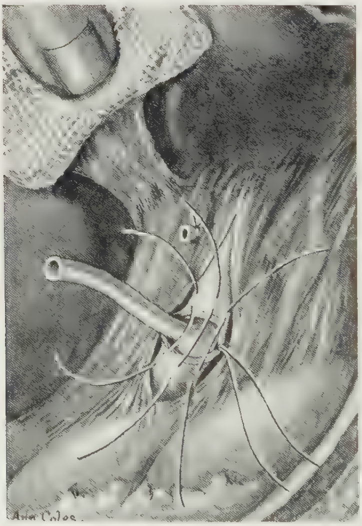


Fig. 3788.—The Same _ IV; _ The posterior sutures having been tied, three silk or Pagenstecher seromuscular sutures are being placed in the anterior wall of both ducts, near their margins _ and between two of these sutures which are about to be tied a T-drain has been inserted. (Redrawn from Kehr.)

ward — and, passing from without inward, ending upon the inner aspect of the choledochus — where they are tied (Fig. 3787). Anteriorly, three seromuscular silk sutures are placed (Fig. 3788) — after the posterior sutures have been knotted within the lumen and the free ends cut. Before the anterior sutures are tied a T-drain is placed between the stitches — one end passing into the hepaticus and the other into the choledochus. These anterior sutures through the outer coats are then tied — thus also coaptating the anterior aspect of the anastomosis, and holding the T-drain in position. The gall-bladder bed is sutured.

The T-drain is conducted out of the abdominal wound — as well as a temporary composite gauze and rubber drain of the extensive operation field.

OPERATIONS UPON THE BILE-DUCTS IN CONJUNCTION WITH THE OPERATIONS OF DUODENOPANCREATECTOMY

These procedures, which are exceedingly complicated, will be found described under the Operations Upon the Pancreas, p. 389.

CHAPTER LXXI

GENERAL OPERATIONS UPON THE INTESTINES APART FROM SPECIAL OPERATIONS UPON THE APPENDICOCECAL AND THE COLO-RECTO-ANAL REGIONS

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SURGICAL ANATOMY OF THE SMALL INTESTINE

Description.—Extend from pylorus of stomach to ileocecal valve. About 7.6 meters (25 feet) long.

Divisions.—Duodenum (from 25.5 to 30.5 cm., or 10–12 inches) _ consists of First or Superior Curved Portion (Superior Hepatic Curve) (not quite 5 cm., or 2 inches); _ Second or Descending (Vertical) Portion (not quite 7.5 cm., or 3 inches); _ Third or Transverse (Preaortic) Portion (about 12.5 cm., or 5 inches); _ Fourth or Ascending Portion (about 2.5 to 5 cm., or 1–2 inches); _ Fifth or Duodenojejunal angle. **Jejunum** _ about upper two-fifths of remaining small intestine (about 2.9 meters, or 9 feet, 7 inches). **Ileum** _ about lower three-fifths of remaining portion (about 4.3 meters, or 14 feet, 5 inches).

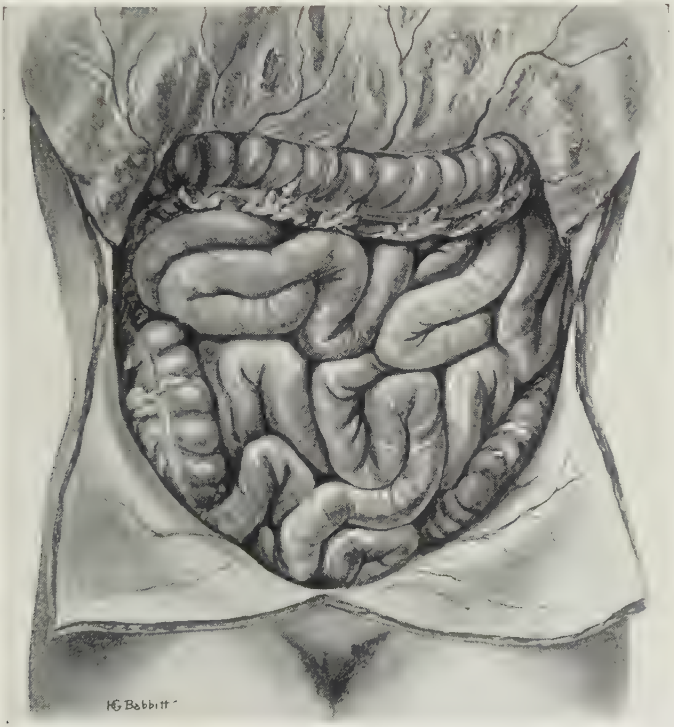


Fig. 3789.—The Small and Large Intestines, *in Situ.*

General Form of Duodenum.—Usually has the form of a U, with which the above description corresponds _ but is sometimes V shaped.

Course and Relations of First or Superior Curved Portion (Superior Hepatic Curve) of Duodenum.—Course; from pylorus, passes upward and backward to right, ending at neck of gall-bladder. **Superiorly and anteriorly;** quadrate lobe of liver; neck of gall-bladder; foramen of Winslow (duodenum forming its lower boundary); hepatic artery. **Inferiorly;** head and neck of pancreas. **Posteriorly;** common bile-duct; vena portæ; gastroduodenal artery; vena cava inferior; first lumbar vertebra.

Course and Relations of Second or Descending (Vertical) Portion of Duodenum.—Course; descends from neck of gall-bladder down right side of vertebral column, from first to body of third or fourth lumbar vertebra – transverse colon crossing its middle third. **Anteriorly;** right lobe of liver (duodenal impression); right end of transverse colon; transverse mesocolon; small intestine; mesentery (right leaf). **Posteriorly;** right kidney, and suprarenal capsule (sometimes); renal vessels; common bile and pancreatic ducts; inferior vena cava; spermatic vessels. **Internally** (to left); head of pancreas; common bile and pancreatic ducts; pancreaticoduodenal vessels; first to fourth lumbar vertebræ and intervertebral disks.

Course and Relations of Third or Transverse (Preaortic) Portion of Duodenum.—Course; from right side of body of third or fourth lumbar vertebra, crosses vertebral column in horizontal or slightly ascending manner, in front of great vessels and crura of diaphragm, molding itself over these structures. **Superiorly;** head of pancreas; superior mesenteric vessels; inferior pancreaticoduodenal artery. **Anteriorly;** root and right and left layers of mesentery; lower layer of transverse mesocolon; superior mesenteric vessels; small intestine. **Posteriorly;** inferior vena cava; aorta; diaphragmatic crura; third and fourth lumbar vertebra.

Course and Relations of Fourth or Ascending Portion of Duodenum. —Course; ascends vertically along left side of spine, from third or fourth lumbar vertebra to side of second or first lumbar vertebra. **Anteriorly;** transverse colon; transverse mesocolon (lower layer): small intestine: mesentery (left layer;) antrum pylori (sometimes). **Posteriorly;** left diaphragmatic crus; left psoas; left renal vessels; spermatic vessels; kidney (internoinferior part). **Internally** (to right); head and neck of pancreas; aorta; fourth or third and second lumbar vertebræ.

Course and Relations of Fifth Part, or Duodenojejunal Angle.—Position; at left side of second or first lumbar vertebra. **Superiorly;** body of pancreas. **Anteriorly;** mesentery (left layer). **Externally;** left kidney (inner border).

Peritoneal Covering of Duodenum.—First part; covered by peritoneum, except parts of posterior surface near vena cava and neck of gall-bladder. **Second part;** covered in front only (except that no peritoneum covers the front opposite the divergence of two layers of transverse mesocolon), **Third part;** covered in front only (except that there is no peritoneum in front opposite root of mesentery). **Fourth part;** covered entirely in front, and partly at sides. **Fifth part;** entirely covered by peritoneum where it becomes jejunum.

Ligaments of Duodenum.—Ligamentum Hepatoduodenale (suspensory ligament of duodenum) – right edge of lesser omentum – from hilus of liver to first part of duodenum. Ligamentum Cysticoduodenale – from neck of gall-bladder to first part of duodenum. Ligamentum Duodenorenale – from summit of right kidney to outer aspect of first part. Ligamentum Duodenomesocolica – from junction of left layer of mesentery with lower layer of transverse mesocolon, to outer aspect of fourth part of duodenum.

Other Fixation-points of Duodenum.—Common bile-duct and pancreatic duct; celiac axis and superior mesenteric artery; fibronervous structures; muscle of Treitz (passing from duodenojejunal angle upward beneath pancreas to left crus of diaphragm).

Fossæ in Neighborhood of Ascending Duodenum and Duodenojejunal Angle.—Inferior duodenal fossa; superior duodenal fossa (these two may coexist); duodenojejunal (mesocolic) fossa (non-coexistent with above two).

Position of Jejunum.—Extends from duodenojejunal angle to beginning of ileum. Position not fixed _ coils of jejunum generally to be found upon left side of abdominal cavity, in left lumbar, left inguinal, and left half of umbilical regions. The upper loops are apt to be more transverse than the lower.

Characteristics of Middle Portion of Jejunum (**as Compared with Middle Portion of Ileum**).—Diameter about 4 cm. (1½ inches). Walls thicker, more vascular, and mucous membrane more complex. Weight of given length greater. No valvulæ conniventes (or poorly marked). Its position.

Mesentery of Jejunum and Ileum (Attachment of Jejunum and Ileum).—(**1**) Passes obliquely from left side of body of second lumbar vertebra downward and to right, crossing spinal column, aorta, inferior vena cava, and third part of duodenum, to right sacro-iliac synchondrosis (or to right iliac fossa). (**2**) Middle and inferior loops of small intestine have longest mesentery _ and are, therefore, generally found in pelvis. Duodenum has no mesentery. Lower part of Ileum has shortest mesentery (opposite right psoas muscle). (3) Mesentery extends from distal end of duodenum to ileocecal junction. Its upper (right) layer is continuous with inferior layer of transverse mesocolon and with peritoneum of ascending colon. Its lower (left) layer joins peritoneum enclosing descending colon and forming sigmoid mesentery. (4) Average length of mesentery (from spine to intestines) from 20 to 25 cm. (8–10 inches).

Position of Ileum.—Extends from lower end of jejunum to ileocecal valve. Position not fixed _ coils of ileum generally to be found on right side of abdomen and pelvis, in right lumbar, right inguinal, and in right half of umbilical and hypogastric regions. The lower loops are apt to be more vertical than the upper.

Characteristics of Middle Portion of Ileum (**as Compared with Middle Portion of Jejunum**).—Diameter about 3 cm. (1¼ inch). Walls thinner, less vascular, and mucous membrane simpler. Weight of given length less. Valvulæ conniventes.

Meckel's Diverticulum of Ileum (Remains of Vitelline Duct).—Blind diverticulum of ileum and directly continuous with its lumen. Length, from 5 to 7.5 cm. (2–3 inches) _ extremes, from 1 to 18 cm. (½–7 inches). Arises about 109 cm. (43 inches) _ extremes, from 30.5 to 305 cm. (1–10 feet) _ above ileocecal junction. Generally lies free in abdominal cavity (instead of passing to umbilicus, as in fetus). But distal end may be connected with umbilicus, or other site, by strong band (remains of enlarged omphalomesenteric vessels). Its presence occurs in about 50 per cent.

Arteries of Small Intestine.—(**1**) Duodenum; pyloric of hepatic; superior pancreaticoduodenal branch of gastroduodenal branch of hepatic; inferior pancreaticoduodenal of superior mesenteric. (**2**) Jejunum and Ileum; superior mesenteric.

Veins of Small Intestine.—Correspond with arteries _ a single vein accompanying each artery.

Lymphatics of Small Intestine.—End in mesenteric lacteals.

Nerves of Small Intestine.—From superior mesenteric plexus, formed by nerves from celiac plexus, semilunar ganglion, and right vagus.

SURGICAL ANATOMY OF THE LARGE INTESTINE

Description.—Extend from lower end of ileum to anus. About 1.5 to 1.8 meters (5–6 feet) long.

Divisions.—Cecum; Ascending Colon; Hepatic Flexure; Transverse Colon; Splenic Flexure; Descending Colon; Sigmoid Flexure (Sigmoid Colon); Rectum.

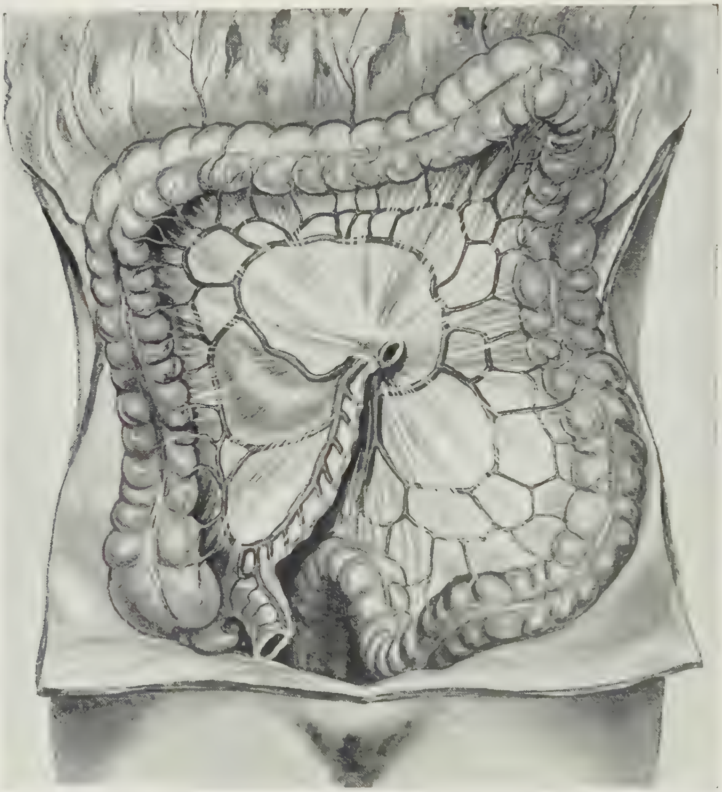


Fig. 3790.—View of the Large Intestine, *In Situ*, with the Small Intestine Removed, the Omentum Thrown Upward, and the Mesenteric Vessels in Evidence. (Redrawn from various Anatomies.)

General Characteristics of Large Intestine (as Compared with Small Intestine).—Greater size; greater fixity of position; sacculations; longitudinal bands; appendices epiploicæ. (Last three characteristics not present in rectum.)

Cecum.—(About 7.5 cm., or 3 inches, broad, and 6.3 cm., or 2½ inches, long.) **Position**; lies in right iliac fossa, above outer half of Poupart's ligament, generally resting upon psoas muscle, sometimes upon iliacus only, sometimes bulk of cecum rests on iliacus and apex on psoas, sometimes free of both, being entirely in pelvic cavity, or even projecting beyond median line. Its apex, or lower point, lies slightly to inner side of middle of Poupart's ligament, just behind anterior abdominal wall and opposite inner portion of psoas. The cecum is entirely covered by peritoneum and lies free in abdominal cavity. There is no mesocecum. Several forms or types of cecum occur (see Appendix). **Anteriorly;** abdominal parietes above outer half of Poupart's ligament. **Posteriorly;** iliopsoas; appendix (origin). **Superiorly;** ileocecal valve. **Internally;** ileum (termination).

Ileocecal Fossæ.—Superior Ileocecal Fossa, an anterior pouch between end of ileum and ascending colon. Inferior Ileocecal Fossa, an inferior pouch under ileum, between it and cecum.

Appendix Ceci.—Description; small blind tube, generally hollow to tip, its lumen continuous with that of cecum and sometimes guarded by valve. Average length, 9.2 cm., or 3¾ inches (extremes, from 3.11 to 23 cm., or from 1¼–9 inches). Diameter, about 6 mm. (¼ inch) at base _ 5 mm. (3/16 inch) at apex. Origin, generally arises 1.7 cm. (11/16 inch) below ileocecal valve, upon its inner and posterior aspect _ but sometimes forms the true apex of cecum. **Course;** variable _ (1) According to Treves, the appendix generally passes upward from behind cecum toward spleen, lying behind lower end of ileum and its mesentery. (2) According to Berry, the order of frequency of position is, "(*a*) pelvic; (*b*) retrocecal; (*c*) internal to cecum, *i. e.*, Treves' position; (*d*) variable." (3) According to Bryant, in order of frequency, "(*a*) inward; (*b*) behind cecum; (*c*) downward and inward; (*d*) into true pelvis." **Relations to peritoneum;** Mesentery always present, but not extending to tip _ about distal third being entirely enveloped in peritoneum and free. Meso-appendix, of triangular form _ derived from left leaf of mesentery _ containing, in its free margin, posterior branch of ileocecal artery (from ileocolic). **Relations to cecum;** four types of cecum occur (Treves): _ (*a*) appendix arising from apex of cecum; (*b*) appendix arising between two sacculi of equal size; (*c*) appendix arising between two sacculi of unequal size (about 90 per cent. of cases); (*d*) appendix appearing to arise from ileocolic junction. **Relations to anterior abdominal wall;** (1) According to McBurney, _ draw straight line from anterior superior iliac spine to umbilicus, and beneath this line, from 4 to 5 cm. (1½–2 inches) internal to the spine, the base of the appendix is found (in right iliac fossa). (2) According to Clado, _ draw a line along outer edge of rectus _ another between anterior superior iliac spines _ opposite the junction of these the base of the appendix is found (in hypogastric region).

Ileocecal Valve.—Opens upon postero-internal aspect, at upper border of cecum.

Ascending Colon.—Description; About 20 cm. (8 inches) in length. Extends vertically upward from cecum to inferior surface of right lobe of liver, at right of gall-bladder (hepatic flexure). Covered by peritoneum anteriorly and laterally, which binds it to posterior abdominal wall. Its posterior surface (where peritoneum is absent) is bound by areolar tissue to quadratus lumborum, transversalis, and right kidney (antero-external part). Mesentery (ascending mesocolon) present in 26 per cent. (Treves). **Relations: Anteriorly;** ileum; abdominal wall. **Posteriorly;** quadratus lumborum; transversalis; kidney (antero-external part). **Superiorly;** liver (right lobe).

Hepatic Flexure of Colon.—Upon under surface of liver, near gall-bladder, the ascending colon bends from posterior abdominal wall sharply to front and left, to become transverse colon.

Transverse Colon.—Description; About 51 cm., or 20 inches (extremes, from 30 to 84 cm., or 12–33 inches), in length. Extends from inferior surface of liver, in right hypochondrium (hepatic flexure), transversely across anterior abdominal wall, with slight downward and forward convexity at its center, to the spleen in left hypochondrium (splenic flexure). Transverse mesocolon is long, and connects transverse colon to posterior abdominal wall – most movable part of large intestine. Transverse colon lies above the umbilicus four times out of five – and below it one time out of five (usually on a line connecting lowest parts of costal arches). Peritoneum entirely surrounds transverse colon. **Relations; Anteriorly;** abdominal wall, great omentum. **Posteriorly;** transverse mesocolon; descending duodenum; small intestine; superior curvature of stomach (at times). **Superiorly;** liver and gall-bladder (inferior surfaces); great curvature of stomach; spleen (inferior end); pancreas (tail). **Inferiorly;** small intestine.

Splenic Flexure of Colon.—Situated beneath lower end of spleen – further back in abdomen than hepatic flexure. Connected by phrenocolic ligament (a fold of peritoneum) passing between splenic flexure to diaphragm, between tenth and eleventh ribs.

Descending Colon.—Description; About 21.5 cm. (8½ inches) long. Extends from splenic flexure vertically through left hypochondrium and lumbar regions to sigmoid flexure. Peritoneum covers it similarly to ascending colon (*q. v.*). Mesentery (descending mesocolon) present in 36 per cent. (Treves). **Relations: – Anteriorly;** abdominal wall; jejunum. **Posteriorly;** diaphragm; left kidney (infero-external part); quadratus lumborum; transversalis. **Superiorly;** spleen, phrenocolic ligament.

Sigmoid Flexure of Colon (Sigmoid Colon).—Description; An S-shaped curve, about 31 cm. (13 inches) long, lying in left iliac fossa, beginning at iliac crest and ending at brim of true pelvis, opposite left sacro-iliac synchondrosis (or opposite upper edge of sacrum). **Divisions;** First Portion, of Colic Limb, tends downward, inward, and slightly forward toward outer aspect of Poupart's ligament and abdominal wall – generally has a short mesocolon (though sometimes peritoneum only anteriorly and laterally). Second or Rectal Part, tends to hang into true pelvis – mesentery about 7.5 cm. (3 inches) – very movable. **Insertion of Sigmoid Mesocolon;** in line extending obliquely from left iliac crest across psoas and left iliac vessels (at about their bifurcation) to join mesorectum at sacral promontory. **Note;** More properly the sigmoid colon, or flexure, should include that portion of large intestine usually described as the first part of the rectum – and then would end where the mesorectum ceases, opposite the third piece of the sacrum, thus having more of an omega than a sigmoid appearance. **Relations: Anteriorly;** abdominal wall; small intestine. **Posteriorly;** left iliopsoas; posterior pelvic wall; rectum.

Intersigmoid Fossa.—In the layers of the mesocolon, generally over bifurcation of iliac vessels – looks downward to left. Sometimes found in children – rarely in adults.

Rectum.—(Length, about 20 to 23 cm., or 8–9 inches.) **Divisions:** First or Superior Part; Second or Middle Part; Third Part, or Anal Canal. **Note;** The rectum will be here described as consisting of three parts, as mentioned. More properly it consists of but two parts, corresponding with the second and third parts just mentioned – the first part above mentioned being, strictly, a portion of the Sigmoid Colon (see "note" under Sigmoid Flexure of Colon). **First or Superior Part;** 8 to 9 cm. (3¼–3½ inches) long. Corresponds with lower part of Sigmoid Colon, as sometimes described. Runs obliquely from left pelvic brim (beginning opposite either sacro-iliac synchondrosis, or sacral promontory, or even right side of base of sacrum) downward, backward, and to right to third sacral vertebra in the median line. Almost entirely enveloped in peritoneum, except posteriorly. Mesorectum connects its posterior aspect to anterior surface of sacrum. Mesentery continuous with sigmoid mesocolon and terminates at third sacral vertebra. **Relations of first part; Anteriorly;** small intestine; sigmoid colon; bladder (posterior surface) in male; uterus (posterior surface) in female. **Posteriorly;** mesorectum; left pyriformis muscle; left sacral plexus; left internal iliac artery and veins; first, second, and one-half of third sacral vertebræ. **Externally;** left ureter; left internal iliac artery and veins. **Description of second or middle part;** 10 to 11 cm. (3–4 inches) long. Extends in a curve from middle of third sacral vertebra to opposite apex of prostate gland – running at first along right aspect of fourth sacral vertebra – thence back to median line about the sacrococcygeal articulation – and passes thence downward and forward to opposite a line connecting the anterior aspects of the two ischial tuberosities, which is opposite the apex of prostate gland, and about 2.5 cm. (1 inch) below tip of coccyx. Partially covered by peritoneum – covered above, anteriorly and laterally – then only anteriorly – and about 2.5 cm. (1 inch) above prostate gland (never more than 8 cm., or $3\frac{1}{8}$ inch) it is reflected from anterior surface of rectum to posterior surface of bladder, in male, or to posterior surface of upper one-fifth of vagina, in female (forming rectovesical or rectovaginal pouch). No mesorectum exists. On posterior surface of rectum there is no peritoneum below a point 12.5 cm. (5 inches) above anus. **Relations of second or middle part of rectum; Anteriorly;** (*a*) In Male; rectovesical pouch; small intestine; bladder (trigone); vesiculæ seminales; vasa deferentia; prostate gland (inferior aspect); (*b*) In Female; vagina (posterior surface); rectovaginal pouch; recto-uterine pouch; small intestine. **Posteriorly;** sacrum (lower portion); coccyx; anococcygeal body; middle sacral vessels; pyriformis muscles. **Description of third part, or anal canal;** about 2 to 3 cm. ($\frac{3}{4}$–$1\frac{1}{4}$ inch) – little less in female. Passes downward and backward, from a point opposite apex of prostate gland (about 2.5 cm., or 1 inch, below tip of coccyx) to end in anus. No peritoneal covering. Surrounded by sphincter muscles. **Relations of third part, or anal canal; Anteriorly;** bulb and membranous part of urethra (male); perineal body (female). **Posteriorly;** anococcygeal body; coccygei muscles. **Laterally;** fatty areolar tissue of ischiorectal fossæ; levatores ani muscles.

Anus.—Surrounded by internal sphincter, levatores ani, and external sphincter. (See Perineum.)

Arteries of Cecum and Colon.—Ileocolic, colica dextra, and colica media, from superior mesenteric; colica sinistra and sigmoid, from inferior mesenteric.

Veins of Cecum and Colon.—Superior and inferior mesenteric, emptying into portal system.

Lymphatics of Cecum and Colon.—Those of ascending, transverse, and descending colon empty into mesenteric glands. Those of sigmoid colon empty into lumbar glands.

Nerves of Cecum and Colon.—Cecum, ascending and proximal half of transverse colon are supplied by superior mesenteric plexus, from celic plexus. Distal half of transverse colon, descending and sigmoid colon are supplied by inferior mesenteric plexus, from aortic plexus.

Arteries of Rectum.—Superior hemorrhoidal (of inferior mesenteric); middle hemorrhoidal (of internal iliac); inferior hemorrhoidal (of internal pudic); branches from sacra media (of abdominal aorta); branches from sciatic (of internal iliac); branches from vaginal, in female (of internal iliac).

Veins of Rectum.—Chiefly from superior hemorrhoidal to inferior mesenteric, and thence to portal system. Some blood passes back by systemic system to inferior vena cava. Anastomosis between systemic and portal systems occurs in rectum.

Lymphatics of Rectum.—Empty into anterior sacral and inguinal glands.

Nerves of Rectum.—From cerebrospinal system (sacral plexus) _ and from sympathetic system (hypogastric and inferior mesenteric plexuses).

INTESTINAL LOCALIZATION

The upper limit of attachment of the mesentery (duodenojejunal angle) generally lies from 8 to 10 cm. (3–4 inches) above the umbilicus, slightly to the left of the median line. The lower limit is about 10 cm. (4 inches) from the middle of the right Poupart's ligament, on a line directed upward and inward in the course of the psoas muscle.

The cecum lies in the right inguinal region, its lower border corresponding, at its center, with the center of a line drawn from the anterior superior iliac spine to the symphysis pubis.

The ascending colon ascends through the right lumbar and hypochondriac regions to the hepatic flexure.

The hepatic flexure lies beneath the liver in the right hypochondrium.

The transverse colon crosses the abdomen transversely at about the junction of the umbilical and epigastric regions _ its superior border lying just below the greater curvature of the stomach _ its inferior border, just above the umbilicus.

The splenic flexure is posterior to the stomach in the left hypochondrium.

The descending colon descends through the left hypochondriac and lumbar regions to the sigmoid flexure.

The sigmoid colon lies in the left inguinal region.

Note.—For the more detailed description of the relations of the parts of the large intestines, see Surgical Anatomy of its special parts.

The general feature of arrangement of the small intestines is that its coils occupy the more central aspect of the abdominal and pelvic cavities _ more or less surrounded to right and left, above, and on the left half of its lower aspect, by the large intestines _ and largely covered by the great omentum.

The only points of fixation of the small intestine are the following: _ the gastroduodenal junction (rather an attachment, or beginning, than a fixation) _ the duodenojejunal junction at the second lumbar vertebra _ and the ileocecal junction in the right iliac fossa.

The mesentery of the jejunum and ileum, attaching them to the posterior abdominal wall, passes obliquely from the left side of the body of the second lumbar vertebra downward and to the right, crossing the spinal column, aorta, inferior vena cava, and third part of the duodenum, to the right sacro-iliac synchondrosis (or to the right iliac fossa). The mesentery extends from the distal end of the duodenum to the ileocecal junction.

According to Mall the coils of the small intestine tend to distribute themselves in four somewhat regular directions and positions: _ (*a*) to the left, toward, or to the splenic flexure of the colon, some passing beneath the transverse colon; _ (*b*) to the right, across the umbilical region, to the hepatic region, to the hepatic flexure of the colon; _ (*c*) to the left loin and iliac region; _ (*d*) into the pelvis, as dependent coils.

Monks has worked out a plan for localizing the parts of the small intestines which has proved of practical value. He draws upon the abdominal wall, a line corresponding with the root of the mesentery, extending from the left side of the body of the second lumbar vertebra, downward and to the right, to end at the right sacro-iliac synchondrosis (or in the right iliac fossa). Using this line as a basis, he divided the abdominal cavity into three zones, by drawing lines at right angles to the ends of the base line (corresponding with the root of the mesentery). In average conditions and patients, the upper zone will contain, approximately, the upper third of the small intestine _ the middle zone, the middle third _ and the lower zone, the lower third. These zones are represented in Fig. 3791.

In order to determine which is the proximal and which the distal end of an exposed coil of the small intestine, Monks has demonstrated that if the Surgeon, while facing the patient, will draw out of the abdomen the coil under investigation _ holding the ends of the coils between the fingers of his right and left hands _ while an Assistant passes his hand down along the mesentery to the spine, to make sure there be no twist _ that the proximal, or upper end of the coil will be in the Surgeon's left hand, and the distal, or lower end, in his right hand _ as seen in Fig. 3792.

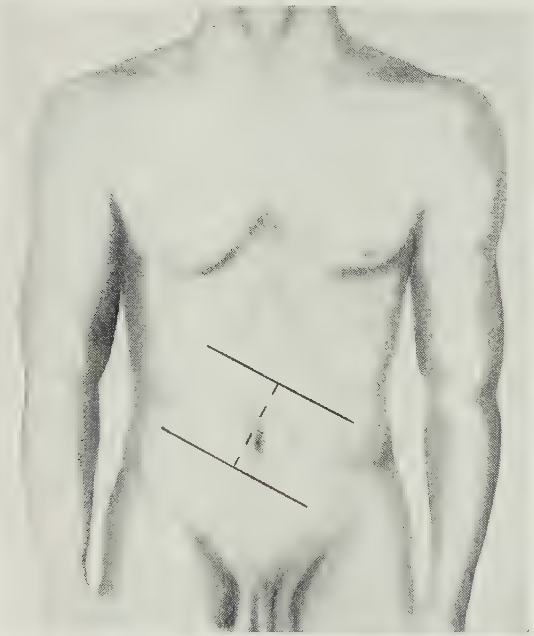


Fig. 3791.—Monks' Method of Localizing the Parts of the Small Intestine; _ The dotted line corresponds with the root of the mesentery, to right angles with which a solid line is drawn at each end. The upper third of the small intestine lies approximately, in the upper zone _ the middle third, in the middle zone _ and the lower third, in the lower zone. (For details see the text.)

Monks has also suggested a method of differentiating the loops of the small intestine based upon the features of their vascularity, which may be more or less available. Upon holding up a coil of intestine against the light, areas of relative transparency, bounded by vascular loops (the vas recta) _ (lunettes, or arcades, as sometimes called) _ are noticed in the mesentery. It has been found that these transparent areas gradually grow smaller, from the proximal, toward the distal end of the small intestine _ that in the upper third of the mesentery of the small intestine the vasa intestini tenuis form simple, or one-story arcades, with comparatively long vasa recta (of

3 to 5 cm., or $1\frac{3}{16}$–2 inches in length) – while in the middle third, the arcades are generally of two or three tiers – and, in the lower third, they are arranged in an irregular network, formed by very short vasa recta of under 1 cm. (6/16 inch) in length.

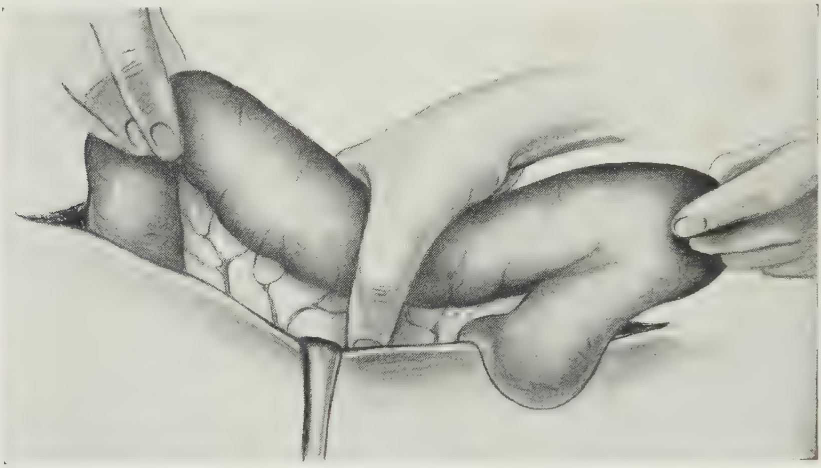


Fig. 3792.—Monks' Method of Determining the Proximal and Distal Ends of an Exposed Coil of Intestine – the left hand holding the proximal, and the right, the distal – while the Assistant's hand examines the mesentery for possible twists. (For details see the text.)

GENERAL SURGICAL CONSIDERATIONS IN OPERATING UPON THE INTESTINES

Preparation of the Patient.—In non-emergency cases, and where functional activity of the bowel is not contraindicated, the intestinal tract should be reasonably freed of its contents by purgation. The abdomen is prepared by one of the usual methods.

The patient should be protected against cold during operation by the artificial application of heat, and the coils of the intestine against chilling, by towels wrung out in hot normal saline solution.

Position.—The patient usually lies supine, in a horizontal posture, near the edge of the table – though, for special purposes and conditions, the Trendelenburg, or reversed Trendelenburg positions may be assumed. The Surgeon may stand upon either side of the patient, but generally stands upon the patient's right, incising from above downward. The Assistant stands opposite the Surgeon.

Anesthesia – Analgesia.—While brief and minor operations in the surgically unfit are sometimes performed under analgesia, anesthesia is ordinarily employed.

Incision of Approach.—This is usually by median abdominal section, for the general run of operations. In special procedures, as, for instance, appendicectomy, or colostomy (inguinal, or lumbar), the particular nature of the operation, and part of the intestine involved, will determine the site and nature of the incision.

In Figs. 3793–3796 are seen useful forms of abdominal retractors.

Peculiarities of the Intestinal Wall Where the Laminæ of the Mesentery Separate to Enclose the Intestines.—In the case of those portions of

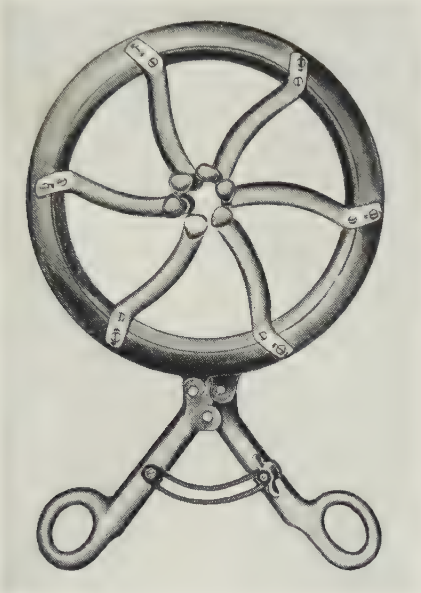


Fig. 3793.—Kothes' Automatic Abdominal Retractor – I; – Closed. (This, and the following view are seen from below – but the handle-clamp should be upon the upper side.)

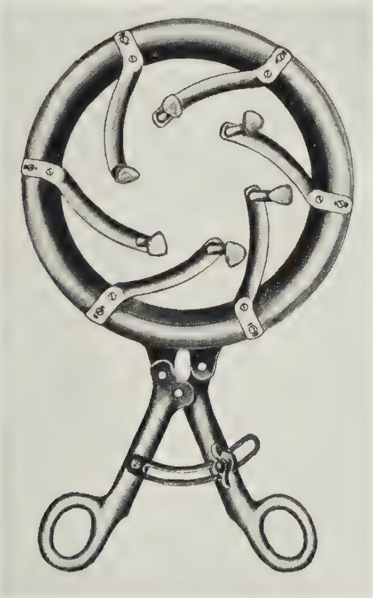


Fig. 3794.—The Same – II; – Partially open. (See note following preceding picture.)

the intestines which have a mesentery, the laminæ of the mesentery begin to separate (in order to surround the wall of the gut) about 1.5 to 2 cm. ($\frac{2}{3}$–$\frac{3}{4}$ inch) from the intestine, leaving, upon these viscera, a triangular interval with a base of about 8 mm. (5/16 inch) where the muscular coat is uncovered by peritoneum – this triangular space being occupied by fatty areolar tissue, vessels, and nerves. The practical bearings of the above fact being: – (1) The necessity of being particularly careful in ordinary suturing, or the adoption of some special form of suturing, in operations upon the intestines, in order to bring the peritoneum of the cut margins into contact with the wall of the intestines at the mesenteric border, thus securing the covering of the denuded tract with peritoneum and also securing apposition of serous surfaces when two ends of intestine are brought together; – (2) The guarding of the blood-supply to the intestines transmitted through this triangular space.

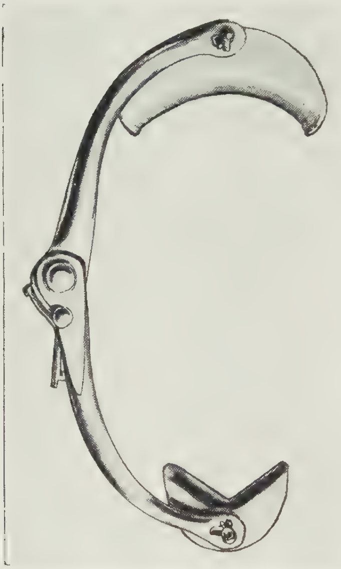


Fig. 3795.—Delagenière's Automatic Bivalve Abdominal Retractor.

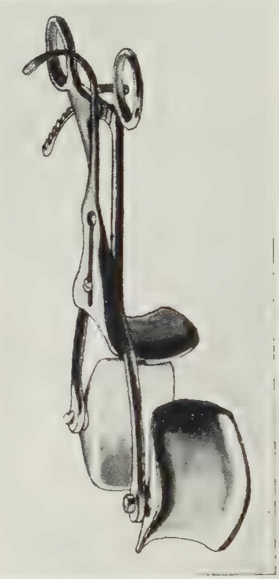


Fig. 3796.—Collin's Automatic Trivalve Abdominal Retractor.

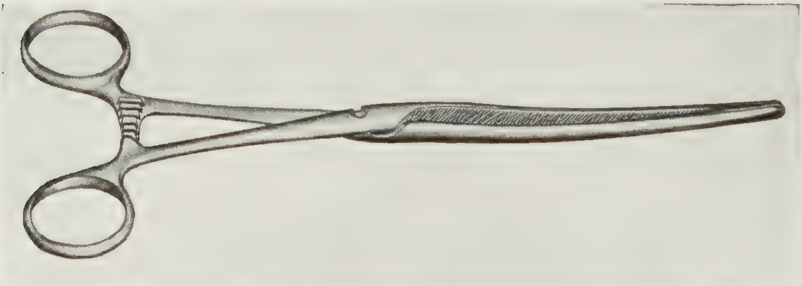


Fig. 3797.—Doyen's Elastic-bladed Intestinal Clamp.

The manner of dealing with this area of the intestine will be mentioned under the different methods of enterorrhaphy.

Clamping the Intestines for Controlling Intestinal Flow.—Various devices are employed for controlling the intestinal contents – improvised clamps of simple and ingenious type – and regular metallic clamps, simple and rubber covered. The one paramount feature in all the varieties of clamping is that the compression exercised should not be sufficient, in degree, or duration, to jeopardize the vitality of the parts – upon which all methods of repair depend. Only a very moderate degree of pressure is needed to control the intestinal flow – any additional compression is unnecessary, and may be harmful. All metallic clamps should so close that their blades will be parallel, and compress the intestine equally throughout – rather than more toward the handles or tips.

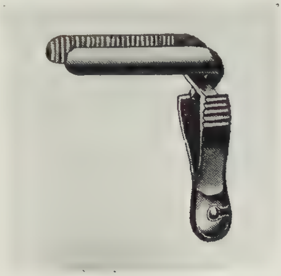


Fig. 3798.—Murphy's Angular Intestinal Clip.

Doyen's type of intestinal clamp (Fig. 3797) is an especially serviceable form.

Other forms of clamps and clips are shown in Figs. 3798–3801.

The shorter clamps are applied transversely. The longer clamps may either be used transversely, as a single clamp – or may be applied to a loop of intestine, from which the contents have been pressed in opposite directions, thus serving as a double clamp – or in lateral intestinal anastomosis.

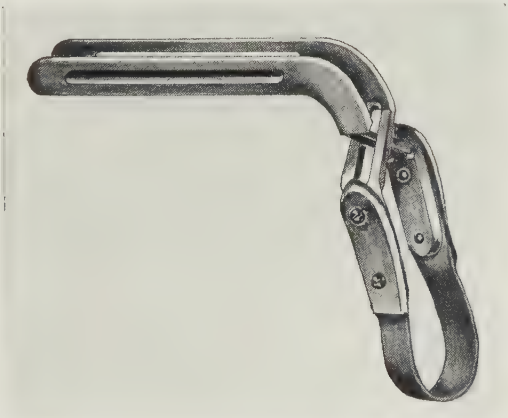


Fig. 3799.—Payr's Stomach and Intestinal Forceps.

Grasping the Intestines for Manipulations.—The greatest gentleness should be employed in handling the coils of intestine in the various operative maneuvers. If this be not done by rubber-covered fingers, it should be accomplished by special intestine-grasping forceps, which are usually protected by some form of rubber at their tips. Such grasping forceps are seen in Figs. 3802–3805.

Prevention of Hemorrhage from Intestinal and Mesenteric Vessels.—Temporary control, as required in enterotomy, is secured through the use of clamps or temporary mass ligature. Permanent control, as in partial enterectomy, is brought about through the ligation of the mesenteric vessels supplying the particular area of intestine involved.

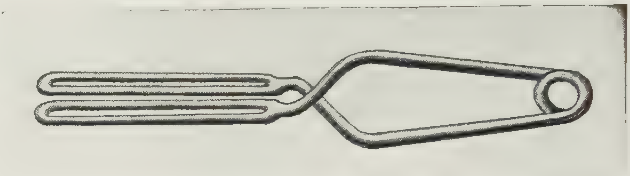


Fig. 3800.—Knapp's Intestinal Forceps.

Substitutes for Clamps in Controlling Intestinal Flow and Hemorrhage.—Many such devices have been ingeniously employed — several of which are pictured and described under Partial Enterectomy, p. 666.

Prevention of Peritoneal Soiling During Intestinal Operations.—More than ordinary care has to be observed in operating upon the intestinal tract, for the contents of the incised viscera are capable of infecting the abdominal cavity, and, owing to the nature of the parts, some degree of external escape takes place whenever the intestinal canal is incised. It is, therefore, necessary to make ample provision in advance of opening any part of the tract.

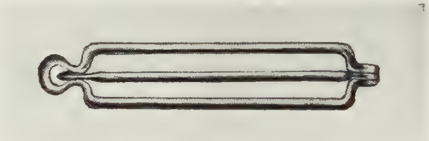


Fig. 3801.—Mutach's Bowel-closing Clip.

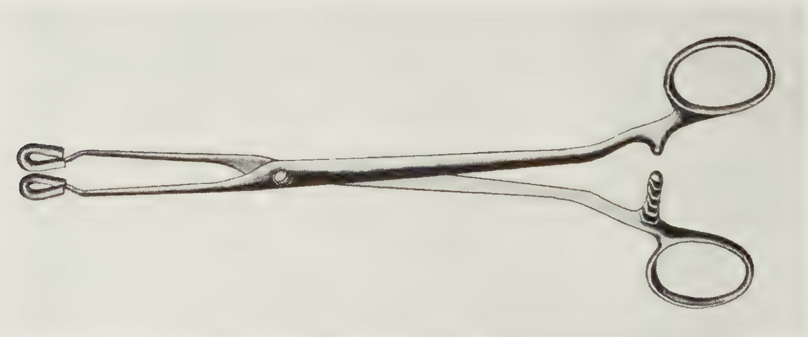


Fig. 3802.—Schoenberg's Intestinal Clamp-forceps

This is best accomplished by abundant gauze, or towel packing, wrung out of warm saline solution — by which not only is the immediate field of operation protected, but the rest of the abdominal cavity is walled off. All such packings should be taped and clamped.

Reposition of Coils of Intestine During or After Operation.—Difficulty, and considerable unnecessary handling, are sometimes experienced in getting back into the abdominal cavity coils of intestine which have either been deliberately withdrawn for examination or operation _ or which have forced themselves out of the opened abdomen. This may be the case, even though the intestines may not be distended _ and the difficulties may be very greatly augmented when intestinal distention coexists. The best method of accomplishing their return is to grasp the center of each lip of the abdominal wound, either with narrow hook-retractors, or with two bent fingers of each hand _ and then to lift the abdominal wall upward as far as possible, separating the lips of the wound at the same time _ and, as a rule, with the inrush of air, the intestines, by combined suction and gravity, will usually readily regain their normal position _ often alone _ or with but very little aid through outside assistance with the flat, or cupped hand. The right and the wrong ways of conducting this technic are shown in Figs. 3806 and 3807.

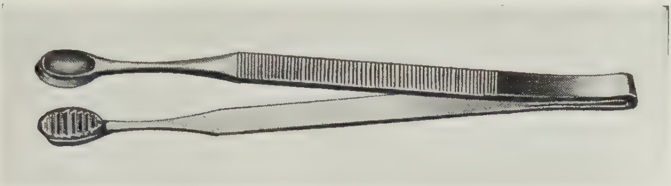


Fig. 3803.—Young's Rubber-tipped Intestinal Forceps.

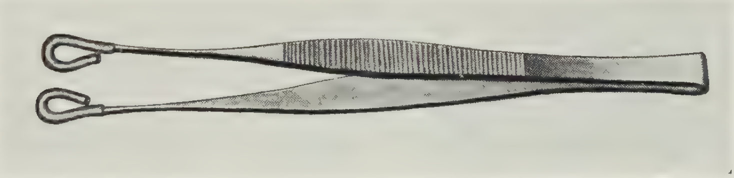


Fig. 3804.—Schoenberg's Intestinal Pincer-forceps _ rubber guarded.

Materials Employed in Intestinal Suturing.—These will be considered under the operation of Enterorrhaphy, p. 632.

Abdominal Drainage Following Operations Upon the Intestines.—This will depend upon the nature of the operation. In average, clean cases, drainage of the site of the operation and of the peritoneal cavity is usually omitted.

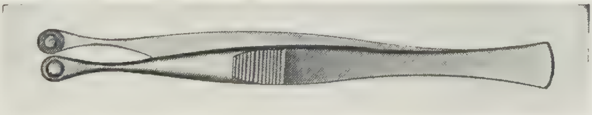


Fig. 3805.—Murphy-Barrett Intestinal Forceps _ with soft-rubber tips.

Note.—For other general considerations bearing upon operations upon the intestines, see the introductions to the special classes of intestinal operations.

Comments.—It will sometimes be found, in intestinal operations, dependent upon the condition, that the coils of the bowel are distended, often very considerably, with either gaseous or fluid contents. This distention may be so great, especially in cases of obstruction, as to make the technical details of the operation impossible of satisfactory performance. Under such circumstances it is indicated to evacuate a portion of either gaseous or fluid contents, or both. This is usually accomplished, after the thorough protection of the vicinity with packings, by means of simple puncture by trocar and cannula, with rubber-tube attachment for carrying off the contents _ or by some more elaborate form of aspiratory apparatus, or suction-drain. The simple puncture is shown in Fig. 3808. Following the evacuation the puncture wound is closed in the same manner as an ordinary intestinal wound of the same nature _ generally by a purse-string suture of the outer coats, reinforced by Lemberts _ as in intestinal wounds, p. 637. On the other hand it is probably easier to reverse the order, and place the purse-string suture before making the puncture, as the distended bowel lends itself to the technic _ and this is tightened immediately on withdrawing instrument and tied _ followed by the protecting Lemberts.

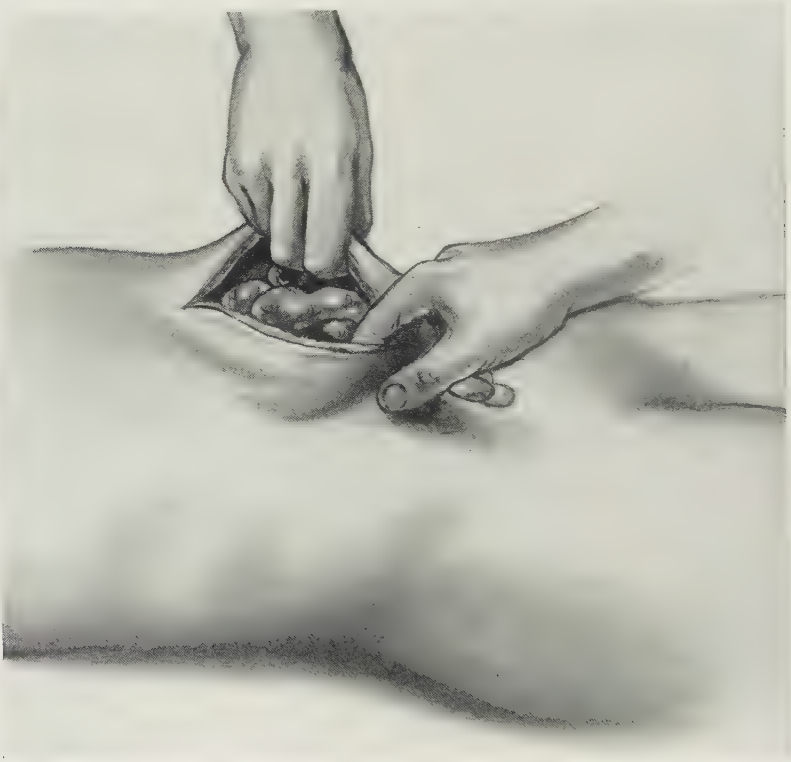


Fig. 3806.—Illustrating the Correct Method of Holding the Abdominal Wound While Replacing Eviscerated Intestines During or After Operation; _ The elevation of the grasped and separated margins of the abdominal wound tending to aid the coils of the bowel to re-enter the abdominal cavity.

Other more elaborate methods of evacuation are sometimes employed.

The method of "milking" away the intestinal contents from the coil of intestine upon which it is proposed to operate is accomplished by taking the

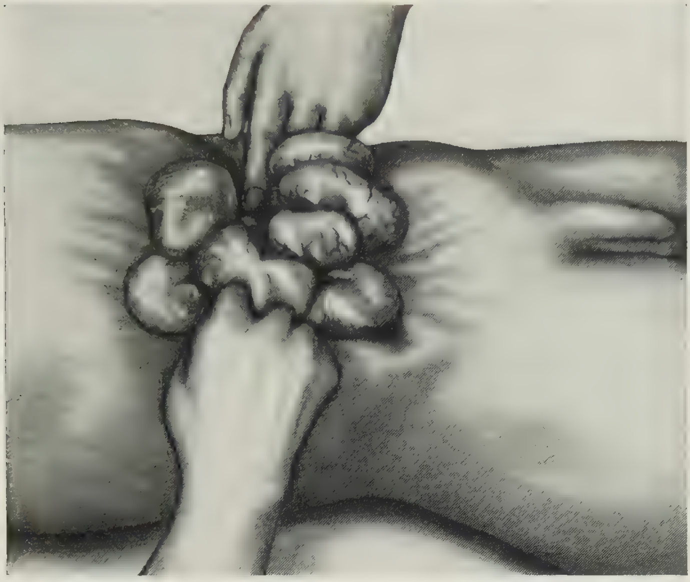


Fig. 3807.—Illustrating the Wrong Method of Holding the Abdominal Wound While Replacing Intestinal Coils Which Have Escaped From or Have Been Temporarily Lifted Out of the Abdomen During Operation; _ Efforts to force the intestines back into the cavity while depressing the abdominal wound and approximating its lips are apt to be followed by escape of additional coils.

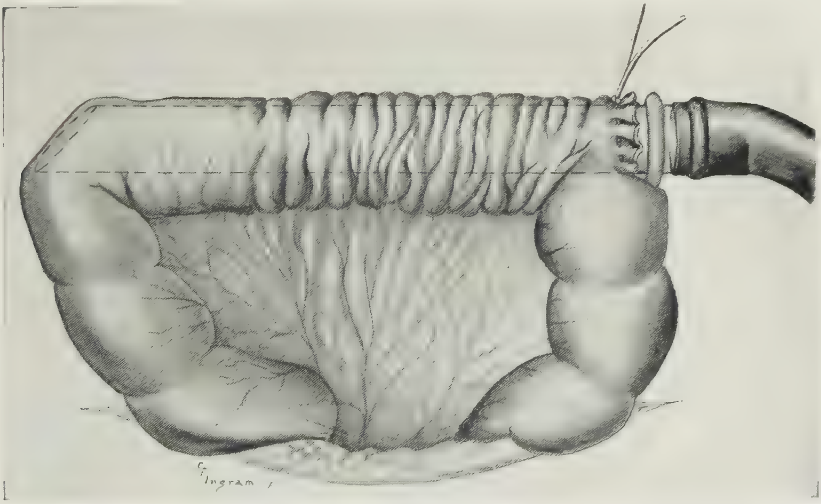


Fig. 3808.—Evacuating the Gaseous or Fluid Contents of Distended Coils of Intestine as a Preliminary Step to Some Operation: _ A considerable length of intestine can be drawn over the flanged glass tube. The purse-string suture usually binds the intestinal opening over the tube, beyond its collar. A rubber tube, attached, conveys the intestinal contents to some receptacle. If the immediate site is not to be excised the intestinal opening is carefully closed after withdrawing the tube.

coil between the first and second fingers of each hand _ pressing the intestine flat as the hands move away from each other _ as seen in Fig. 3809. Each end is clamped within the fingers, before the fingers of that end are relaxed.

Innumerable methods of intestinal control by technical and improvised clamps have been employed — the principle, however, being the same in all — that is, the temporary arrest, by compression, of the intestinal flow alone, — or, simultaneously, of the intestinal flow and of the mesenteric blood-supply

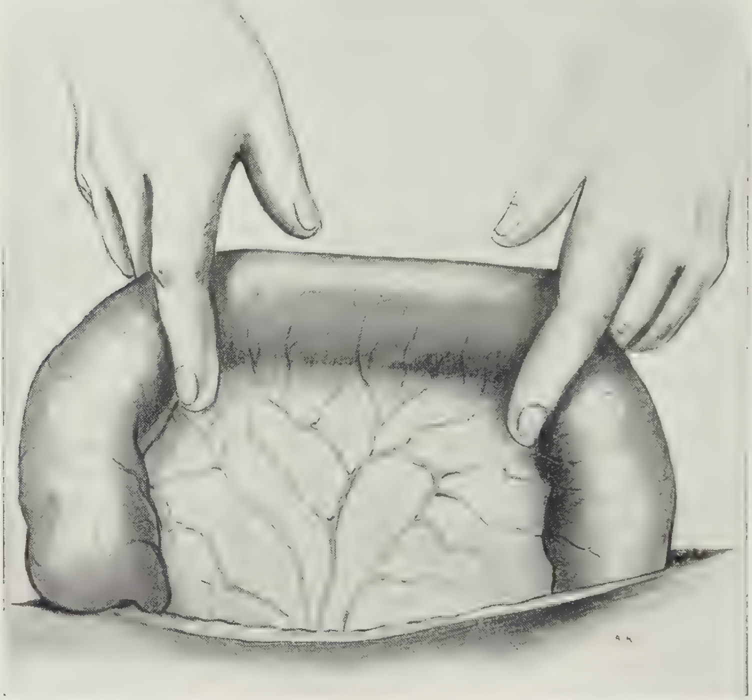


Fig. 3809.—"Milking" Away the Intestinal Contents, Proximally and Distally, Before Including the Tract Between Clamps.

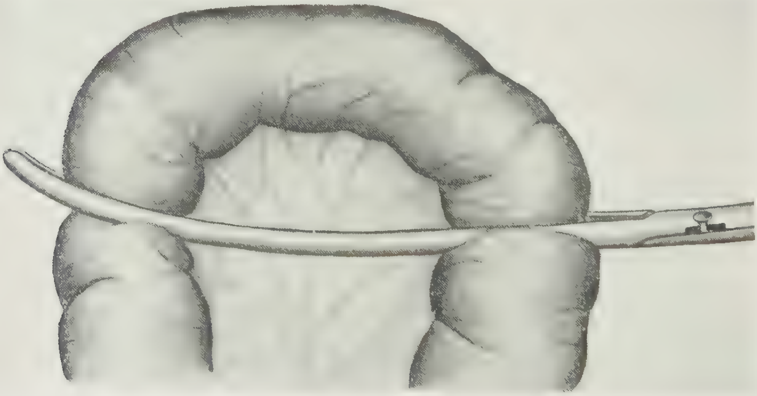


Fig. 3810.—Method of Simultaneously Clamping the Afferent and Efferent Limbs of an Intestinal Coil, Transversely Along with its Mesenteric Vessels, by Means of a Single Curved Doyen Intestinal Clamp.

of the corresponding segment. The application of two intestinal clips after the "milking" process has just been illustrated above. The control by transverse clamping of both limbs of the loop is shown in Fig. 3810, in which, simultaneously, the mesenteric vessels are also controlled by a single clamp.

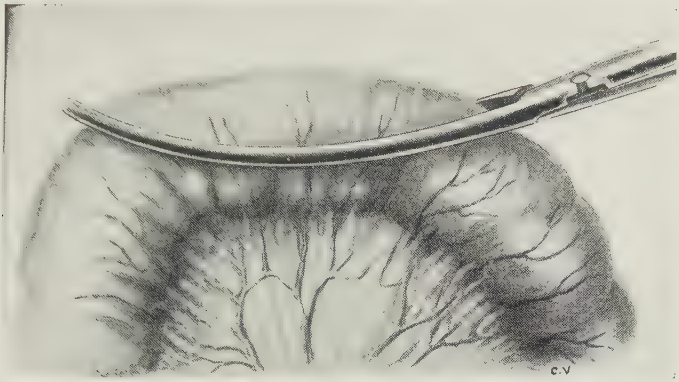


Fig. 3811.—Method of Axially Clamping Off a Part of the Intestinal Lumen by Means of Curved Intestinal Clamps _ while maintaining a partial intestinal flow. Intestinal clamps are usually rubberguarded.

The blocking of only part of the lumen of a coil, by axial clamping, by means of a curved Doyen clamp, is seen in Fig. 3811 _ where no vascular control, proximal to the intestine, is exercised. A simple, but effective form of improvising temporary ligaturing of the limbs of an intestinal loop is seen in Fig. 3812, where two rubber cords, or tubes (catheters) are employed, after making an opening in a relatively non-vascular part of the adjacent mesentery and then loosely knotting the rubber cords, so as to control both intestinal flow and vascular supply.

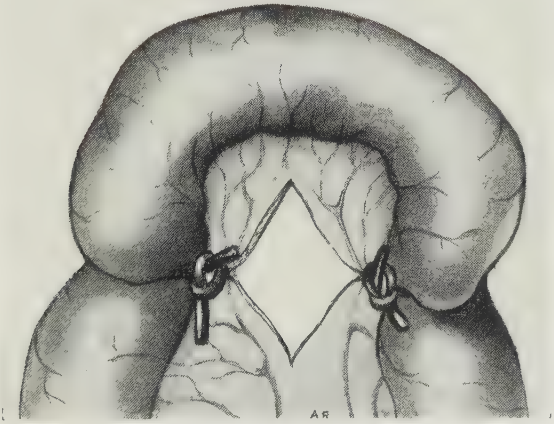


Fig. 3812.—Double Elastic Temporary Ligature of an Intestinal Loop for Temporary Control of Intestinal Flow as Well as the Mesenteric Blood-supply. The rubber cord, or tubing, passes through an opening in a non-vascular portion of the mesentery (which is subsequently closed by suture).

ENTEROTOMY

Description.—The incision of the intestine, followed by closure of the intestinal wound by suture, at the same sitting. The term "enterotomy" was formerly, though wrongly, used synonomously with enterostomy _ in which latter case the opening made in the intestinal tract is intended to remain patulous for a shorter or longer time. Enterotomy applies, etymologically, to any part of the intestinal canal, small and large _ but it is better, and more accurate, to attach the significant ending to the part of the intestine cut _ such as duodenotomy, jejunotomy, ileotomy, cecotomy, colotomy, and rectotomy. The incision into the intestine is usually made axially, in the mid-anti-mesenteric aspect of the intestine _ but may be made transversely. It is to be noted that Kocher endorses the transverse form of enterotomy, as being the normal incision for the intestine, in that it corresponds with the course of the intestinal vessels. Theoretically this is true, but, practically, it would seem ill advisable _ for, in subsequent suturing, it is conceivable that the suture might strangulate a vessel that happened to lie immediately adjacent to, and parallel with, the cut margin, of one side or the other, and thus cut off the blood-supply so necessary for the surgical repair of the sutured part _ even to the extent of causing local death of the margin whose blood came from the next parallel vessel. On the other hand, in axial enterotomy the blood-supply is necessarily preserved right up to the very margin of the sutured edges, as the sutures run parallel with the course of the vessels.

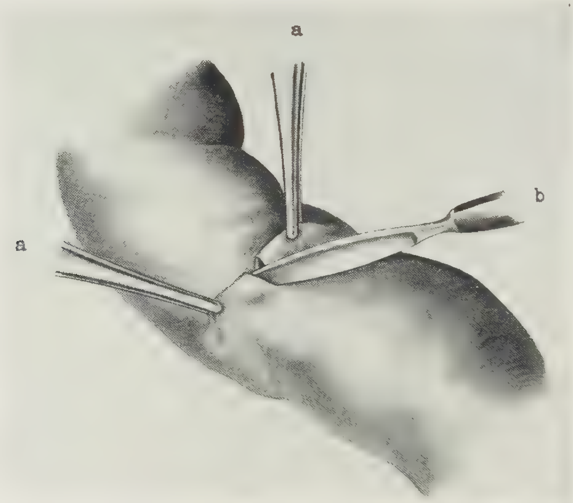


Fig. 3813.—Enterotomy, Axial, by Knife: _ **a, a,** Forceps so grasping the walls of the intestines as to form an elevated, somewhat tensed, transverse ridge; _ **b,** knife cutting into the lumen of the intestine. The section may also be made with scissors.

Indications.—The incision of the intestine is usually performed for the removal of foreign bodies, _ for the evacuation of fluid or gaseous contents, in distention, _ or as one of the steps in some surgical procedure.

Preparation _ Position _ Landmarks _ Incision.—As in Median Abdominal Section (q. v.).

Operation.—Having exposed that portion of the intestine which is to become the site of the operation, the coil involved is lifted out of the abdominal cavity and placed upon a warm wet, sterile towel _ the rest of the abdominal cavity and the other coils of intestine being protected by gauze packing. The intestinal contents are pressed away from the site to be opened and the intestine is clamped proximally and distally to the operation site.

Incision into the intestine is made upon its antimesenteric border, and generally in the long axis of the gut _ exercising care that the opposite intestinal walls be not injured. If the canal contain a foreign body, this may usually be cut down upon directly, its presence protecting the other coats. Otherwise the Assistant should so hold the gut that its walls are separated while the Surgeon makes a rapid, controlled stab into the lumen with a sharp, narrow bistoury, in order that the mucous membrane may not be simply protruded ahead of the incision. The keeping of the opposite walls apart during incision is best accomplished by gently grasping the lateral aspects of the intestine (a little nearer the antimesenteric than the mesenteric border) with forceps (or with the fingers, or thread retractors passing only through the outer coats) and drawing them apart laterally, while the mesenteric border is simultaneously drawn downward, thus forming a hollow triangle within the lumen of the gut (Fig. 3813). The wound in the intestine may be enlarged in the act of withdrawing the original bistoury _ or by means of a blunt-pointed bistoury separately inserted _ or one blade of blunt-pointed scissors may be introduced and the opening thus enlarged. Care is used in preventing any unnecessary escape of intestinal contents _ and all sites of possible infection are packed off. The object of the operation having been accomplished, the wound in the intestine is closed by one of the methods of intestinal suturing described under Enterorrhaphy. The abdominal wound is closed in the ordinary manner.

Instead of making the opening into the intestine by knife, scissors may be used _ as shown in the accompanying picture. The intestinal wall is first ridged up between two pairs of forceps, so as to present a prominent ridge to the scissors.

And, as mentioned under Description, the opening may be made, though less wisely in the judgment of the Author, transversely athwart the intestine.

The enterotomy wound may be closed by any of the forms of intestinal suturing _ usually by through-and-through marginal sutures, followed by a reinforcing tier of Lemberts (v. p. 637).

MOYNIHAN'S METHOD OF ENTEROTOMY, WITH TUBAL EVACUATION OF INTESTINAL CONTENTS FOLLOWED BY SUTURING OF THE INTESTINAL WOUND

This is a method whereby a considerable length of the intestinal tube, proximal and distal, may be very thoroughly freed of gaseous and fluid contents.

The coil of intestine which is to be evacuated is drawn out of the abdominal cavity. The abdominal wound and the eviscerated coil are well surrounded with ample wet, warm towel or gauze packing. Prior to making the opening, the immediate antimesenteric area into which the opening is to be made is surrounded by a circle of non-penetrating suturing, passing through the outer coats _ which is very much more easily applied at this stage of distention. The axial incision is then carefully made into the prominent aspect of the intestinal coil, for a distance equivalent to the diameter of the tube to be used _ after having made ample provision for the protection of the surrounding parts from the immediate gush of fluid and gas which is apt to occur. A beveled and flanged glass tube, from 15.2 to 20.2 cm. (6–8 inches), with a long enough piece of rubber tubing attached to conduct the intestinal contents to some distance from the wound, is then inserted through the opening into the lumen of the bowel. It is first carried proximally, to its full length _ after which, additional length of the intestine, up, it is said, to from 8 to 10 feet, may be drawn over the tube, by slipping it along in pleats, or folds, by means of the fingers. When this is accomplished, the same maneuver is applied to the distal end of the bowel.

Intestinal irrigation may also be performed while the tube is *in situ* _ as well as for the deposit of sulphate of magnesia solution.

At the end of the operation the tube is carefully withdrawn _ and the purse-string suture tightened and tied. Finally, the site is reinforced by several interrupted Lembert sutures.

One may vary the method of suturing by closing the margins of the opening with a tier of through-and-through sutures, before tightening the previously placed circular suture of the outer coats.

Comments.—This method may be converted into a method of suction drainage by connecting the rubber tube to one of the many forms of suction apparatus.

Evacuation of the intestine by puncture has been described and pictured under General Surgical Considerations at p. 631.

ENTERORRHAPHY, IN GENERAL

Intestinal suturing is the basis of intestinal surgery. Until the satisfactory closure of this tract by suture was made possible the field of surgical interference was limited _ and, indeed, only after original methods were simplified and bettered, was progress marked.

The union of intestinal margins and paramarginal surfaces will be first considered, under the various methods of simple enterorrhaphy as applied to divisions of intestinal tissue short of complete transverse section of the bowel. The methods of uniting completely divided portions of the intestine will be described under intestinal anastomosis, or entero-enterostomy, by end-to-end methods.

The great advance made upon the through-and-through intestinal suture was the introduction of the Lembert non-penetrating, seromuscular suture _ which passes through the serous and muscular coats and into the submucosa, but, avoiding the mucosa, and approximates opposite serous surfaces (not margins) _ resulting in union of the apposed endothelial intestinal surfaces, which constitutes the bond of strength. The seromuscular suture may be used as the only form of suture _ or, as more usual, may constitute the reinforcing stitch, applied after some other form of suturing.

It is to be noted that while the Lembert suture does not theoretically penetrate all the coats of the intestine, yet frequently must do so _ for, to possess its greatest efficiency, it must include some or all of the more or less resistant submucosa _ which is so thin as to make it impossible to accurately gage it, in the passage of the needle. Practically, harm rarely follows.

Fundamental Forms of Simple Suture.—Sutures, as elements, are of two kinds: _ Interrupted, where each suture is formed of a separate thread, _ Continuous, where the entire line of suturing is formed of one thread. No hard-and-fast line of discrimination can be drawn between them as to worth. It may be said, in a general way, that the chief features in favor of interrupted sutures are, _ that the strain is upon many rather than upon one thread, and is more evenly distributed, _ that the blood-supply of the edges of the intestine is less interfered with, _ and that the giving away of a single thread is not so serious. The chief feature in favor of the continuous suture is its rapidity of application

Linear enterorrhaphy is generally employed in suturing limited wounds, or incisions of the intestine, whether in the long axis, obliquely, or transversely. Circular enterorrhaphy is usually used in suturing the entire circumference of the intestine after complete transverse or oblique division of the bowel.

Characteristics of a Satisfactory Intestinal Suture.—The following, modified from Treves, are the features possessed by the best forms of suture: — (*a*) Two broad peritoneal surfaces should be brought into contact. (*b*) Closure should be tight enough to hold water. (*c*) The mucous membrane, if included, should not be penetrated by the same suture which passes through the serous coat (which might enable the intestinal contents to escape by capillarity). If only one tier of suturing be used, the mucous membrane should not be included. (*d*) Suturing should not be sufficiently tight to strangulate the edges of the intestine compressed by the sutures. (*e*) The method should be simple enough to be easily and rapidly carried out. (*f*) The suture should take a sufficiently firm hold of the intestine to run no chance of tearing out when put to a fair test. (*g*) The suture should pass through the serous, muscular, and part of (into) the relatively strong and thick submucous coat. (*h*) The material of suture must be sufficiently durable and of non-irritating quality.

General Considerations in Intestinal Suturing.—The intestine involved is exposed through the simplest incision, generally by median abdominal section, or by enlargement of a previous wound. The portion of intestine to be operated upon is drawn out of the abdomen and laid upon a warm towel wrung out of sterile normal salt solution, and steadied by an Assistant.

Some form of intestinal clamping should be used to prevent the escape of the contents of the gut. One clamp should be placed upon the proximal and one upon the distal side of the site operated upon. The index-finger and thumb of each hand may be used in place of an instrumental clamp, though generally less satisfactorily. Before the application of any manner of clamping, the contents of the intestine should be pressed away from either side of the site of operation by a process of manipulation resembling that of milking — so that the tract included within the clamps may be as free of intestinal contents as possible.

Avoid, as completely as possible, the escape of intestinal contents — and if the escape be inevitable, provide for the catching of the escaping fluid upon abundant gauze packing, which is immediately removed and other put in its place.

Control all unnecessary hemorrhage by making incisions in as non-vascular regions of the site to be operated upon as possible. All bleeding vessels are caught with artery forceps and tied with fine silk or catgut, preferably the latter, in the case of smaller vessels.

The general feature of intestinal suturing is to bring surfaces of serous membrane into contact for union — preceded or not by a primary tier of suturing which approximates the mucous coats alone or all the coats.

Theoretically, it is well to aim at including part of the submucous coat, but, practically, what is generally done is to include all of the serous and most of the muscular coats. The submucous coat of the intestine is tough and strong, and it should be the aim to include it in all intestinal suturing — though it is sometimes difficult to include the submucous without also including the mucous coat.

While theoretically it is well not to have the same suture which passes through the serous also pass through the mucous coat, yet practical experience has shown that in many instances where this is done no harm has resulted _ and some Surgeons do not attempt to avoid it _ though it should, however, be avoided if possible.

All sutures should be tied with a Surgeon's knot. In intestinal suturing it would seem that the use of two tiers of different kinds of suture makes a better juncture than the two tiers of one kind _ thus a continued and interrupted combined may be considered better than two continued or two interrupted.

Interrupted sutures have a tendency to permit lateral expansion at the site of suturing _ continuous have the opposite tendency _ and therefore, theoretically at least, the latter encroach more upon the lumen of the gut. The interrupted form of suturing may generally be considered the better form of intestinal suturing in the majority of cases.

Often the suturing can be expedited by placing two or four temporary silk traction sutures through the serous and muscular coats in such a position as to draw into two parallel folds or ridges the two edges to be apposed when the traction sutures are held by an Assistant who draws upon them.

Needles should be used which displace rather than cut the tissues through which they pass on their way through the intestinal coats. The straight domestic needle or the instrument-makers' round straight or curved needle is the best. The curved needle always, and the straight needle sometimes, require a needle-holder.

The abdominal cavity should be cleansed, if soiled, at the end of the operation _ by means of gauze mops.

Whether or not the abdomen will be closed without drainage will depend upon the nature of the case. In simple, clean suturing, the abdomen is closed without drainage.

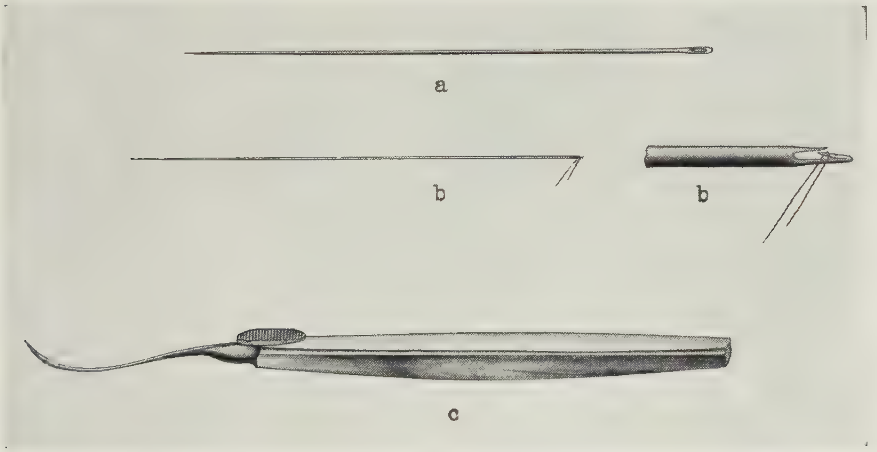
Very many forms of intestinal suture are used _ only those most generally employed will be here given.

Needles for Intestinal Suturing.—Needles used for intestinal suturing should be round in body and at point and tapering _ so that they rather push away the intestinal tissue as encountered rather than cut it. Sharp-edged needles cut _ and the subsequent suture tends to further cut when the knot is tied. An ordinary cambric needle (Nos. 6 to 8, and from 3.7 to 5 cm., or $1\frac{1}{2}$–2 inches long) suffices _ but special needles are made for the purpose. An admirable needle is the Mayo straight intestinal needle (Fig. 3814, **a**) _ made upon the model of the long Keith abdominal needle, but round throughout and tapering, of different sizes, and of such length as to enable them to be held in the fingers. Both straight and curved needles should be on hand _ the latter being used in a holder. Thimbles are sometimes used with these needles, especially with the shorter types _ but are scarcely necessary. The needle should not have a greater diameter than the thread which it carries _ in order that the thread may entirely fill the hole made by the needle _ and thereby not serve as a capillary drain from within the intestine, as would occur, at least theoretically, in the case of those stitches which might penetrate the entire thickness of intestinal wall.

Calix-eyed needles are sometimes used, owing to the ease with which they may be threaded. The eye of the Paterson calix-eyed needle (Fig. 3815, **b**) is so shaped as to grip the thread. A form of Reverdin needle (Fig. 3816, **c**) is made with rounded shaft and tapering point for intestinal work _ with which, as with Reverdin needles in general, suturing can be done more rapidly than in any other way. In some localities and in some forms of intestinal suturing a curved needle, held in a holder, is absolutely needed. The Mayo long intestinal needles for hand-holding are sometimes represented with ordinary eyes _ and sometimes with elongated eyes, narrowing toward the blunt end of the needle, which results in the gripping of the thread against slipping, as does the Paterson needle. While the calix of the Paterson needles opens upon the side, that of the ordinary calix-eyed needle opens in the middle of the blunt end.

It is to be remembered that while the needle may be no larger, in diameter, than the single thread, the part of the thread which is doubled will increase the size of the opening during the time of its passage. This is generally not a practical consideration, as the reactionary swelling of the needle puncture probably quickly closes around the needle-and-thread wound.

Materials Used in Intestinal Suturing.—The following substances are employed in suturing the intestines:—(*a*) Fine, strong silk is the most commonly used—preferably colored black, for more easy detection. The twisted Chinese or Japanese silk is usually selected—the latter being more closely twisted—and, for corresponding sizes, therefore, is stronger and absorbs less. Any size of Japanese silk is said to be as strong as Chinese silk of two sizes larger. The silk may be used plain or paraffined (lessening its absorption). Fine braided silk is sometimes used. (*b*) Pagenstecher's celluloid yarn, or linen thread of fine grade, is often used; it is quite strong and absorbs less than silk—being used next most frequently to silk for non-absorbable sutures. (*c*) Catgut, of fine grade, and plain, or chromic is often employed, especially for inner tiers of suturing, including the mucosa—and for hemostasis, either as ligature or suture. It is generally used as an inner tier, with silk or linen, as an outer tier of suturing. It is thicker, less smooth and unwieldier than silk or linen, and does not make so fine and strong a knot. Its absorbability is its chief advantage.



Figs. 3814–3816.—Forms of Needles Useful in Intestinal Suturing:—**a**, Mayo's long intestinal needle;—**b**, Paterson's calix-eyed intestinal needle;—**c**, Reverdin's intestinal needle (Jalaguier model).

To summarize, it may be said that probably the majority of Surgeons prefer fine catgut (plain or chromic) for sutures which involve the mucosa—and paraffined twisted silk for those of the outer coats and tiers.

Comments.—The ultimate fate of intestinal sutures will differ according to circumstances. Absorbable sutures which penetrate the mucosa undergo rapid disintegration. Non-absorbable sutures which penetrate all the coats, or which become exposed within the lumen during healing, are eventually cast off into the intestinal canal. Non-absorbable sutures which do not come into contact with the lumen, usually remain as partially or entirely buried sutures, according to the method of suturing

A convenient way of handling interrupted sutures is that suggested by Halsted. A number of 30.5 to 35.5 cm. (12–14 inches) lengths of suture are threaded upon needles _ which are then sewed loosely, lengthwise, into a folded towel _ and then rolled up and sterilized.

One should avoid encroaching too much upon the caliber of the bowel, whatever method of suturing may be adopted.

No mechanical device is necessary in the simple suturing of intestinal wounds or incisions, such as are considered under the present heading _ other than the clamps which isolate the part of the bowel being operated upon _ the forceps which manipulate the parts which are being sutured _ and the needle and thread, with sometimes the use of a needle-holder. This is in contradistinction to the very many forms of mechanical aids to suturing which have been introduced, and were formerly largely used in uniting the ends of divided intestine (to be described at pp. 741–745).

Some Surgeons prefer the continuous form of suture. Makins states that it is more rapid _ accomplishes the best coaptation of surfaces _ secures the safest hemostasis without having to tie individual vessels _ and, in circular suturing, following entero-enterostomy, affords support to the intestine in the event of distention of the bowel. For the reasons mentioned at p. 632, however, many prefer the interrupted suture. Further, some Surgeons have especially recommended interrupted sutures, as against continuous suturing, in entero-enterostomy, because interrupted sutures do not prevent the distention of the bowel, and make unlikely the tearing, under distention, as may occur in a bowel-junction held together by a continuous suture of fixed length.

The continuous suture has the advantage, as Makins mentions, of fewer knots.

In some methods of suturing the mucosa is united by a single tier, and the outer coats by a second tier.

It is practically important, for strength, that the outer tier of sutures should not only pass through the serosa and muscularis, but should dip into the submucosa _ while attempting to avoid penetrating the mucosa.

A very large number of varieties of intestinal suturing have been worked out, for the simple suturing of wounds and incisions _ and even a larger number for the anastomoses between ends and sides of intestine, many quite bizarre. In the present consideration of repairing simple wounds and incision of the bowel only the methods of more general usage will be given.

Simple intestinal suturing may be grouped under three headings, _ methods of repair by interrupted sutures _ methods of repair by continuous suturing _ and methods of repair by combined interrupted and continuous suturing.

There is more tendency now than formerly in two directions _ to depend upon a single tier of intestinal sutures _ and to let that tier penetrate all the coats of the margin of the intestinal wound. Such evidences will be seen in the following pages in the single-tier, penetrating sutures. In spite of this, however, it seems more prudent to use a double tier _ and, if one tier penetrates into the lumen, to reinforce this tier by a second tier which does not enter the lumen.

Similarly, is there a greater tendency to use absorbable and non-absorbable sutures indifferently _ in spite of which it, nevertheless, is probably still a better policy, where two tiers of suturing are employed, to let the penetrating tier be of absorbable material, and the reinforcing tier be of non-absorbable material. If a single tier of suturing be used, it is much safer, in such important suturing, that the single tier be of silk or Pagenstecher.

ENTERORRHAPHY BY LEMBERT'S INTERRUPTED SUTURE

Description.—The suture is carried across at a right angle to the line of intestinal wound to be closed _ the needle picking up a fold on one side of the wound _ and a similar fold on the directly opposite side _ whereby, when the knot is tied, the serous surfaces of the two lips of the wound are approximated and the edges of the wound are invaginated into the lumen of the gut (Fig. 3817).

The fold of serous, muscular, and part of submucous coats picked up will be about 3 to 5 mm. ($\frac{1}{8}$–$\frac{3}{16}$ inch in width) _ the needle emerging about 2.5 to 3 mm. ($\frac{1}{10}$–$\frac{1}{8}$ inch) from the edge of the wound _ entering the opposite lip of the wound at the same distance from its edge and traversing the same amount of tissue as on the first side. The sutures will be about 3 to 5 mm. ($\frac{1}{8}$–$\frac{3}{16}$ inch) apart.

All sutures are placed before any are tied _ except that where the line to be sutured is somewhat long a few sutures may be applied at intervals and at once tied, so as to evenly divide and fix the parts. The knots are not to be tied too tightly (for fear of cutting through or strangulating the parts) _ and are cut quite short (so as not to interfere with the process of invagination of the edges).

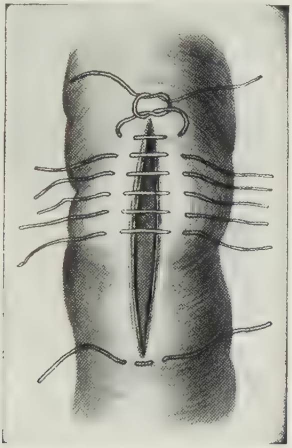


Fig. 3817.—Enterorrhaphy by the Lembert Interrupted Suture.

The sutures are generally applied with one long thread and a single needle, cutting the thread at the end of each completed suture. Or numerous needles may be threaded with short lengths of thread.

Four temporary traction sutures, passed through the outer coats of the intestine, placed on the opposite sides of the wound and at each of its ends, if drawn upon in a line with the suturing, will raise two parallel folds which will make the insertion of sutures easier, more rapid, and more regular. They should be placed just to the outer side of the lips of the wound so that the folds caused by their traction will represent the surfaces which are to be approximated by the permanent sutures.

For manner of application of interrupted and continuous Lembert sutures see Fig. 3818.

Comments.—The Lembert suture, interrupted or continuous (v. p. 637), represents the best type of intestinal suturing, but is chiefly used as a reinforcing suture, in conjunction with some other stitch. The suture was originally only an interrupted suture — and, at first, included only the serous coat.

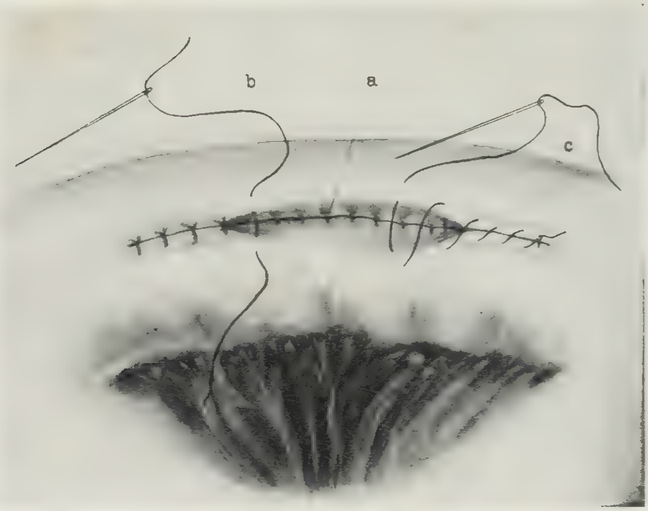


Fig. 3818.—Lembert Suturing; — The margins of the enterotomy wound having been closed, for strength, by continuous, non-penetrating or penetrating sutures, a — this first suture line is reinforced, for safety against leakage, by either interrupted Lembert sutures, b — or by continuous Lembert suturing, c.

When the Lembert suture is tied, the margins of the intestine are inverted, and relatively broad surfaces of the intestinal wall are approximated for endothelial union. Care should be exercised not to draw the individual

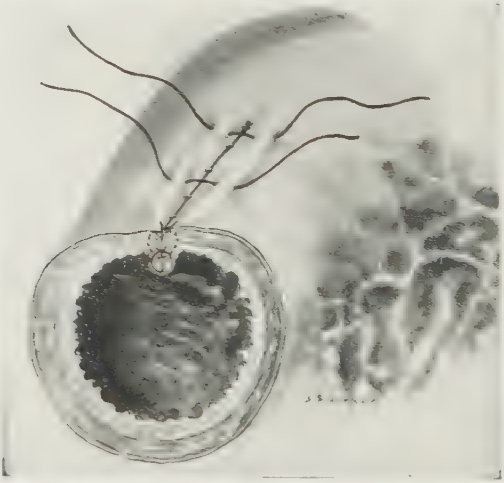


Fig. 3819.—Interrupted Lembert Suture Seen in Cross-section; — Overlying and burying in the through-and-through marginal suture.

sutures too tightly before knotting — for fear of strangulating the blood-supply of the part. The surfaces should simply be snugly brought together.

Judgment is to be used in determining the amount of transverse ridges of intestinal wall picked up by the stitch – their distance, from the margins of the incision, of entering and leaving the intestinal substance – and their distances from each other – by the circumstances of the individual case rather than by any rule of measurement.

As the stitches pass in the direction of the muscle-fibers, if they be drawn too tightly they may cut out.

The interrupted Lembert in cross-section is seen in Fig. 3819.

ENTERORRHAPHY BY THE COMBINED CZERNY-LEMBERT INTERRUPTED SUTURES

Description.—By this method the mucous membrane and part of the submucosa are first separately sutured with the Czerny suture, the sutures being so introduced as to bring the knots within the lumen – and then the serous, muscular, and part of the submucous coats are united by the ordinary Lembert method.

The passage of the Czerny suture is a little difficult if it be desired to have all the knots fall within. The mucous membrane of one side of the wound is caught with delicate forceps and steadied, and, at the same time, drawn forward into view and slightly everted – a curved needle, held in a holder, is then passed from the mucous surface of the mucous membrane outward entirely through that membrane and part of the submucous coat – then the mucous membrane of the opposite edge of the wound is similarly seized with forceps, and, while similarly held, except without eversion, the needle is now passed in the reverse direction, from without inward, through part of the submucous coat and the mucous membrane. The two ends of the thread are therefore toward the lumen and, when tied, the knot will be within. When tying the last one or two knots it will be necessary to protrude them within the lumen with the blunt end of a probe. The above method of applying the sutures is especially necessary in suturing short wounds and in completing the line of circular suturing after resection of the intestine. For two-thirds of the distance in circular enterorrhaphy, following intestinal resection, the Czerny sutures can be readily applied – it is only toward the latter part, when the lumen is almost excluded, that their application becomes more difficult. If there be any likelihood of the first part of the last one or two knots slipping, make that part a friction-knot.

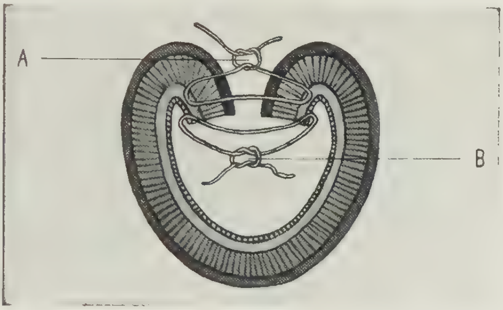


Fig. 3820.—Enterorrhaphy by the Czerny-Lembert Interrupted Suture: – A, Interrupted Lembert suture through serous, muscular, and part of submucous coats – applied from without; B, interrupted Czerny suture through mucous and part of submucous coats – applied from within The latter is applied first. (Modified from Esmarch.)

The passage of the Lembert sutures is accomplished in the usual fashion — and, when tied, completely covers in the Czerny sutures.

Some Surgeons apply the sutures through the mucous membrane in the ordinary manner, tying the knots toward the surface, depending upon the Lembert row to bury them.

For the manner of applying the suture see Fig. 3820 — and also see the Czerny-Lembert Entero-enterostomy Method.

Comment.—Confusion often exists between the Czerny-Lembert and the Wölfler sutures. They are practically the same.

This combination of suturing is not now employed as much as formerly — but it is the best combination of suturing in which the inner tier penetrates some of the inner coats, and the outer tier some of the outer coats — and neither tier, all of the coats.

ENTERORRHAPHY BY THE COMBINED ALBERT-LEMBERT INTERRUPTED SUTURES

Description.—In this method the margins of the intestinal incision are first brought together by a through-and-through suture of all the coats — followed by the ordinary Lembert stitch. While this method is not universally known under the above title, it is probably the method of intestinal suturing most frequently employed.

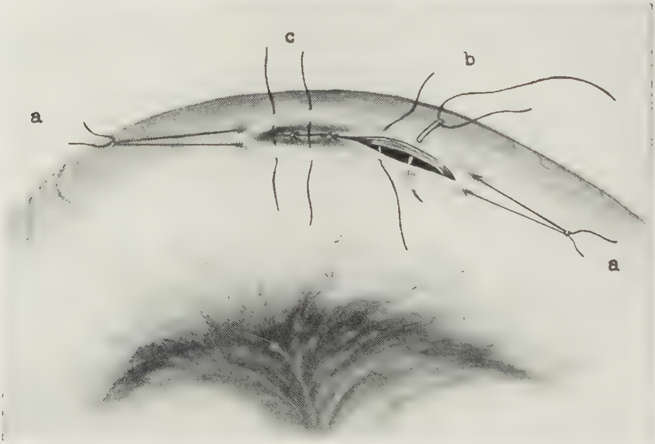


Fig. 3821.—Enterorrhaphy by the Combined Albert-Lembert Sutures: — **a, a,** Non-penetrating traction sutures to tauten and make parallel and prominent the margins of the wound; — **b,** through-and-through marginal sutures of all the coats; — **c,** reinforcing Lembert sutures of the seromuscular submucosal coats.

The sectional view of this combination of stitches has been given under Operations Upon the Stomach, (q. v.) — (where, also, the technic has been explained at length). The surface view is seen in Fig. 3821.

Fine catgut, plain or chromic, is employed for the marginal row of sutures which penetrate all the coats (Fig. 3821, **b**). This tier is then followed by a second tier of fine silk or Pagenstecher Lemberts (Fig. 3821, **c**).

Comments.—This technic seems, unquestionably, to be the method of intestinal suturing chosen by the majority of Surgeons.

This procedure is sometimes varied according to the judgment and view of the individual Operator, so that the marginal suture penetrates the serosa, muscularis, and part of the submucosa without piercing the mucosa.

ENTERORRHAPHY BY HALSTED'S INTERRUPTED QUILT- OR MATTRESS-SUTURE

Description.—This is a modification of the Lembert principle – and consists in an ordinary quilt- or mattress-suture (the terms being used synonymously) so applied that the looped end is upon one side of the wound and the two free ends upon the opposite side – the thread passing through the serous, muscular, and especially a part of the tough submucous coats.

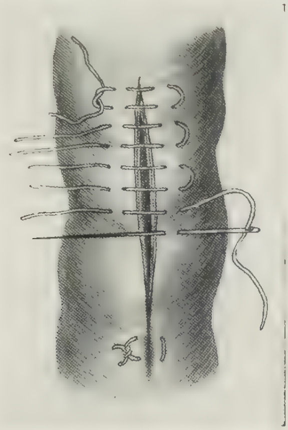


Fig. 3822.—Enterorrhaphy by Halsted's Interrupted Quilt- (or Mattress-) Suture .–Applied by ordinary needle

As to the manner of their application, each quilt-suture may be regarded as composed of two parallel Lembert sutures, united by the loop. When the knot is tightened, folds of serous surfaces from the two sides are brought into contact – the fold on one side being held by the loops – on the other, by the knots.

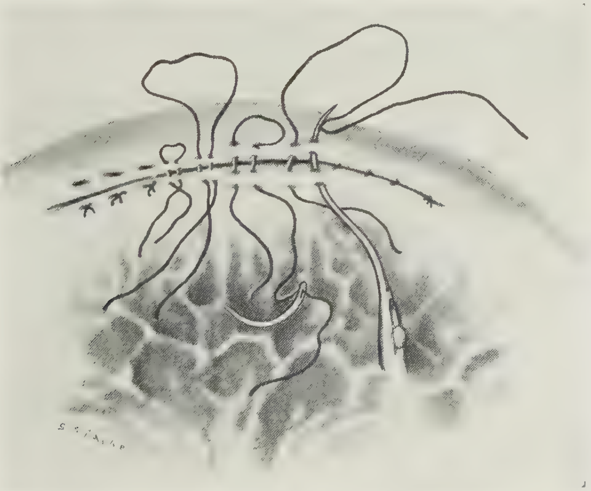


Fig. 3823.—Halsted's Interrupted Mattress- or Quilt-suture; – Applied by the Reverdin needle (which is here shown too coarse.)

For manner of application see Fig. 3822.

Comment.—It is claimed that these sutures compress the tissues less, take a stronger hold, and approximate the parts more accurately. It is probably the next best interrupted suture to Lembert's.

The finished suture line has a somewhat greater degree of small puckerings about it than has the approximation following the simple Lembert sutures.

The stitches, however, take a good grip upon the parts – and are especially serviceable where the tissues are friable, and, therefore, apt to tear out.

Mattress-sutures are much more easily and rapidly placed by means of the intestinal type of Reverdin needle than by ordinary needle (Fig. 3823).

The Halsted stitch is often preceded by a through-and-through marginal stitch.

ENTERORRHAPHY BY LEMBERT'S CONTINUOUS SUTURE

Description.—This suture passes diagonally back and forth from side to side, between the lips of the intestinal wound, excluding the margins, passing through serous, muscular, and part of submucous coats. When the suture is drawn together two folds of serous surfaces, parallel with the edge of the wound and parallel with each other, are brought into contact.

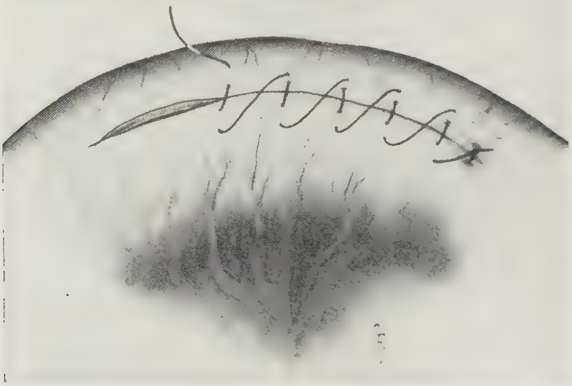


Fig. 3824.—Continuous Lembert Suture Seen in Cross-section.

The general principle of the introduction of the continuous Lembert suture follows that of the interrupted Lembert suture – except that the former is applied continuously, and the needle punctures are made in a direction slightly obliquely to the cut margins of the intestinal wound (the thread crossing the wound at a right angle) – the general rule as to the distances being about the same in both methods.

For the manner of application see Fig. 3818.

Comment.—The most quickly applied of the regular continuous intestinal sutures approximating serous surfaces – and preferred to interrupted Lemberts by some Surgeons.

The Lembert continuous suture is, in effect, a modification of Dupuytren's suture.

ENTERORRHAPHY BY CUSHING'S RIGHT-ANGLED CONTINUOUS SUTURE

Description.—In this method of suturing the thread is carried along in its onward progress exactly parallel with the edges of the wound in the intestine – and when the wound is crossed the crossing is always directly at right angles to the course of the wound. The suture is everywhere buried except where it crosses the wound, and even this part of the suture is buried by the invagination of the lips of the wound when the suture is drawn tight.

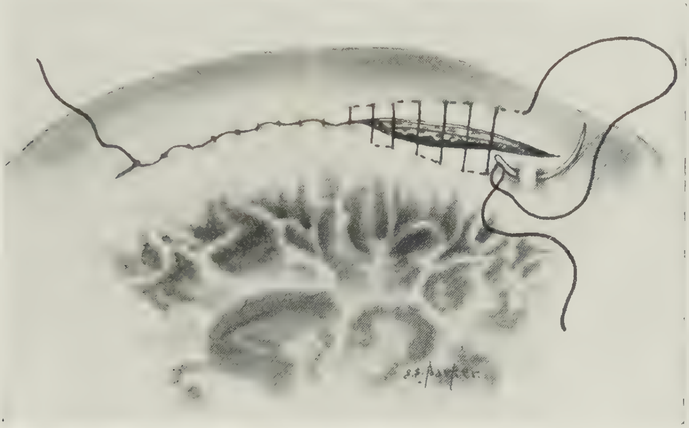
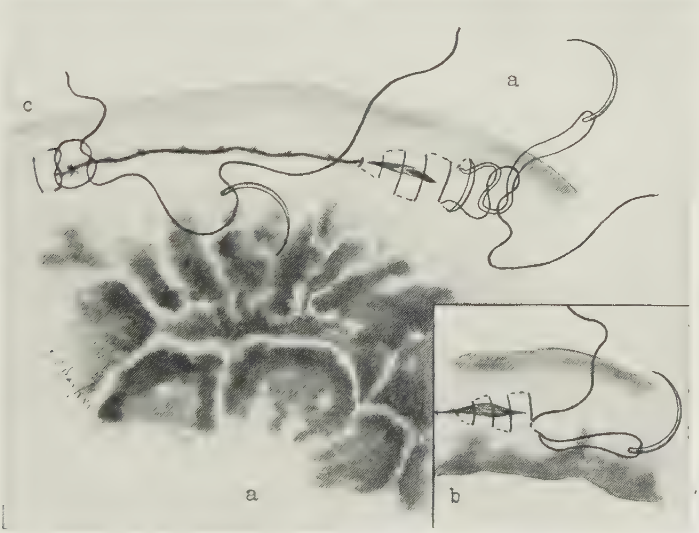


Fig. 3825.—Cushing's Right-angled Continuous Suture.

While the passage of the intermediate portion of the suture, as originally worked out, is simple, the beginning and ending of the stitch are somewhat complicated. The suture, in its entirety, is more readily understood by pictorial than by graphic description. In Fig. 3825, the details of the beginning and continuation of the stitch are shown _ and in Figs. 3826 and 3827 is seen the stitch in the act of being tightened _ as well as a simplified manner of ending.



Figs. 3826 and 3827.—Cushing's Right-angled Continuous Suture: _ **a**, The original technic; _ **b**, detail of the beginning of the ending stitch; _ **c**, simplified method of beginning. In a simplified method of ending the single limb of the suture, on one side, may be knotted with the double limb of the suture upon the opposite side.

One would be inclined to give preference to the simple continued Lembert stitch in comparing the two.

Comment.—As the only complicated parts of the stitch, as originally devised, are its beginning and ending, and as these features are not of paramount importance, the initial and final knots may be simplified as the Surgeon desires _ as, for instance, as follows: _ Having begun the suture by passing through the serosa, muscularis, and into (not through) the submucosa, a short distance from and directly opposite one end of the wound, the end of the thread is knotted in the ordinary manner (a knot that is large enough not to pull through the intestinal wall) _ the needle is then carried inside of the intestinal wall (not inside of the intestinal lumen) onward, to a point a short distance to one side of the edge of the wound _ traveling forward between the submucosa and muscularis, parallel with the edges of the wound _ to emerge a short distance beyond _ crossing, outside, at a right angle to the wound _ to a point on the other side directly opposite its last emergence _ and thence travels similarly forward between muscularis and submucosa for a short distance _ thence back across the wound, at a right angle, to the original side _ and thus on to the opposite end of the wound, beyond which it is carried for a short distance _ and is then knotted by tying the free end on one side, the looped end on the opposite. Before the final knotting the thread is drawn tight, thus infolding the margins of the wound and approximating the serous surfaces. This simplified technic has been shown above.

ENTERORRHAPHY BY COMBINED OVERHAND CONTINUOUS SUTURE OF ALL COATS, FOLLOWED BY INTERRUPTED LEMBERT SUTURING OF OUTER COATS

Description.—This method consists, first, in whipping together the edges of the wound by a simple, running, continuous, overhand suture, passing through all the coats of each margin of the wound as a preliminary suture of approximation and strength _ which is then followed by a secondary tier

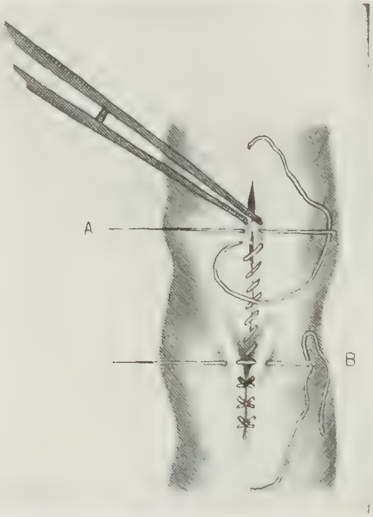


Fig. 3828.—Enterorrhaphy by Combined Overhand Continuous Suture of all the Coats, Followed by Interrupted Lemberts of the Outer Coats: _ A, Continuous overhand marginal suture; B, interrupted Lemberts.

of either the interrupted or continuous Lembert sutures passing throughthe serous, muscular, and part of the submucous coats.

For the manner of application to a limited wound see Fig. 3828. For the general description of the method see Entero-enterostomy by Simple Suturing.

The through-and-through marginal suture is usually of fine catgut, chromic or plain _ and the tier of Lemberts of silk (or Pagenstecher).

In the judgment of the Author this is the method of choice in intestinal suturing _ in axial intestinal wounds (but not in encircling suturing).

ENTERORRHAPHY BY COMBINED THROUGH-AND-THROUGH CONTINUOUS MARGINAL SUTURE, FOLLOWED BY GOULD'S INVERTED MATTRESS-SUTURES

Description.—This combination constitutes a very solidly buttressed type of suturing _ which might find especial application in friable tissues, out of which the ordinary form of single-thread suture may tear under tension.

The margins of the intestinal incision, or wound, are brought together by an ordinary continuous through-and-through fine catgut suture. The second tier of sutures then consists of a series of silk mattress-sutures so applied that the loop of each stitch will be inverted and lie nearer the sutured margin (Fig. 3829) _ rather than in the opposite direction, as is usually the case (and as shown in Fig. 3823).

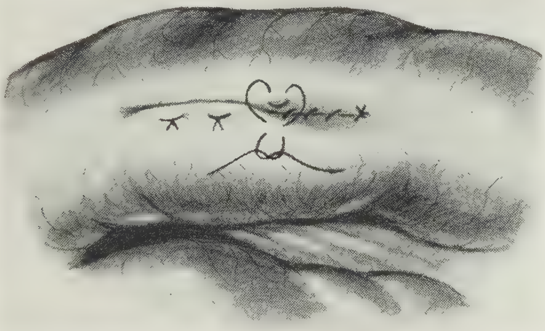


Fig. 3829.—Gould's Inverted Mattress-suture _ overlying the through-and-through marginal suture.

The method is somewhat more difficult of application than is that in which the ordinary mattress-sutures are used _ so that the individual Surgeon will have to decide whether the additional advantage is compensatory.

ENTERORRHAPHY BY AN INVAGINATING FURRIER'S SUTURE

Description.—This method of suturing consists of a marginal stitch, penetrating all the intestinal coats _ and may be used either as the only tier of suturing, or as the first tier, reinforced by Lembert suturing. When employed as the only suture, its takes a broader grip upon the margin, so as to appose greater widths of serosa _ and when used as the first of two tiers it may take in somewhat narrower widths of margin.

After passing through all the coats and being knotted on the outside at the end of beginning of the stitch, it passes directly into the lumen of the intestine, to the opposite side _ which it pierces from within outward _ thence directly across to the first side, which it passes through from within outward

_ and so on, to the opposite end _ where the free end, on one side, is knotted, with the loop on the other.

The stitch, in other words, always crosses the wound at right angles _ making its onward progress diagonally on the outer surface _ and always passes through the walls of the intestine, on both sides, by penetrating the walls from within outward.

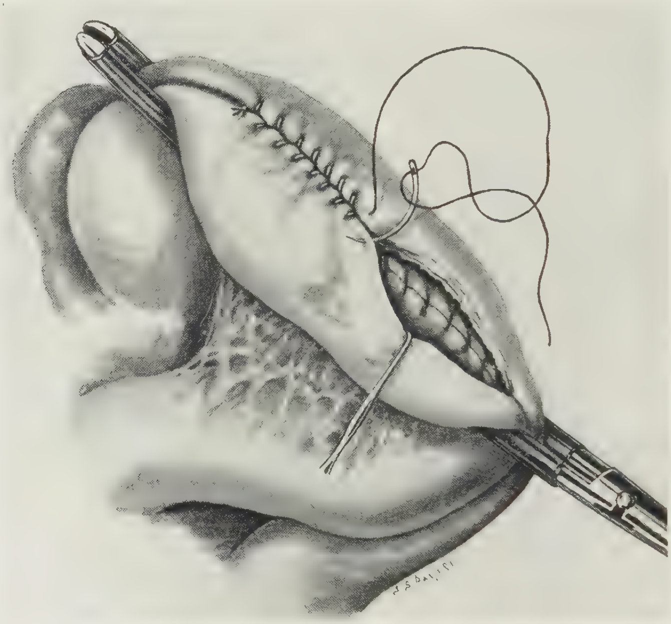


Fig. 3830.—Lateral Entero-enterostomy by Means of an Invaginating Furrier's Suture.

The method of its application is shown in Fig. 3830. It will be seen that the margins are everywhere turned inward _ and, further, that the amount of serosa brought into contact, on the two sides, will entirely depend upon the width of margin included in the stitches.

THE REPAIR OF INTESTINAL WOUNDS

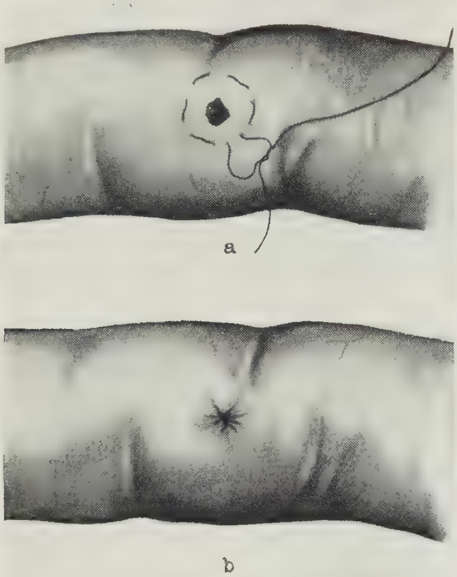
Varieties of Intestinal Wounds.—Wounds of the intestine may be punctured, incised, lacerated, gunshot, or contused, in nature _ and longitudinal (or axial), transverse, or irregular, in form. They may range, in degree, from mere bruising, or mere division of some of their coats, to complete division of the bowel. Perforation of the intestinal tract may also come from disease, as, for instance, those connected with typhoid fever.

The objects sought by operation are: _ repair of the intestinal wound, or, if too extensive, excision of the involved part of the bowel, followed by intestinal anastomosis _ arrest of any active bleeding which may be continuing _ control of intestinal contents and peritoneal infection _ and the repair of damage to neighboring structures.

Preparation _ Position _ Landmarks.—While, naturally, these largely depend upon the nature and position of the wound _ they usually partake of the features of an emergency abdominal section.

Incision.—Will be chiefly determined by the position of the wound of the abdominal wall. If the abdominal wound which may already exist, lie outside of either rectus, and especially if it be surmised that the course of the wounding object has ranged away from the middle line, the incision of entry is often made directly over the external abdominal wound.

Operation.—Having entered the abdominal cavity, the edges of the wound should be well retracted in order to expose the involved coils of intestine. All bleeding vessels should be controlled by clamp and gut ligature before proceeding to the intestinal operation. If the omentum be found wounded, the lips of the wound should be approximated by gut suture. Unless the wounded coil of intestine be readily detected, it is best to systematically examine the intestines, beginning at the stomach — lifting the stomach and transverse colon to trace the duodenum — and then, catching up the beginning of the jejunum beneath the ligament of Treitz, follow down the rest of the small and large intestines.



Figs. 3831 and 3832.—Purse-string Suturing of a Punctured Wound of the Intestine: — **a**, Placing the Lembert suture; — **b**, the same, tied — inverting the area between the margin of the wound and the suture.

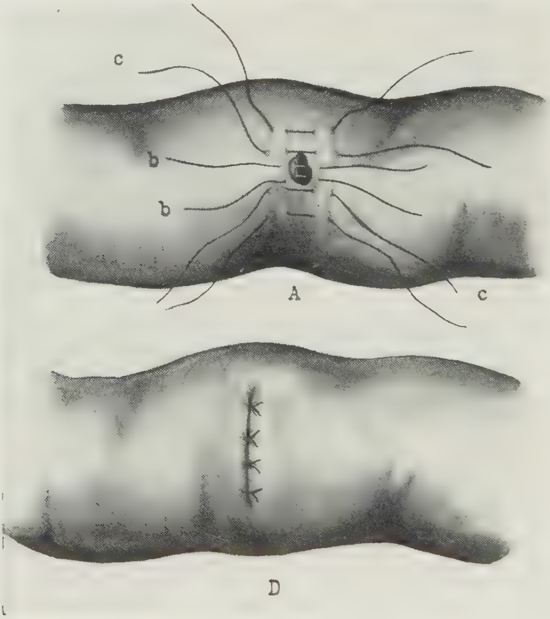
Some Surgeons clamp each wound, in the case of gunshot wounds, as found — and suture none until all are clamped — in order to control intestinal contents. Coils of intestine temporarily removed from the abdominal cavity should be surrounded with warm, wet, sterilized gauze or towels. All escaped intestinal contents should be wiped away with gauze. If the mesentery be wounded, the edges of the wound should be sutured with gut sutures.

Having brought the involved portion of intestine into the field of operation, the wound is repaired as indicated by the special case.

Punctured, gunshot, or small incised wounds may often be effectually closed by silk purse-string suture of the continuous Lembert type, entering the outer coats and passing into the submucosa (Fig. 3831, **a**) — which, when tied, inverts the wall of the intestine into the intestinal lumen (as seen in Fig. 3832, **b**).

Such wounds may also be very satisfactorily closed by first bringing together the margins of the wound by one or more through-and-through catgut sutures (Fig. 3833, A, threads **b** and **b**. These are tied _ and then outlying interrupted Lemberts of silk are placed (the same figure, letters **c** and **c**). Finally, when the Lemberts are tied, the wound presents the appearance shown in Fig. 3834, D. Juvara, cited by Schmieden, has devised a clever form of crossed mattress stitch, possessing Lembert features, whereby small openings may be inverted (as shown in Figs. 3835 and 3836) _ which, however, does not seem as secure as either of the preceding.

Simple longitudinal wounds, of somewhat greater length, are conveniently closed by a preliminary, marginal, catgut, through-and-through, interrupted, or continuous suture _ followed by an outlying tier of interrupted or continuous silk Lembert suturing _ as already illustrated in Fig. 3824.



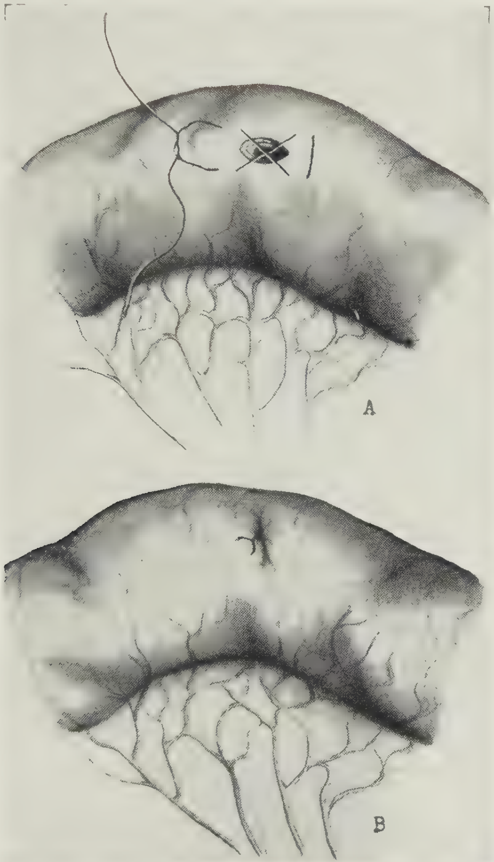
Figs. 3833 and 3834.—Marginal and Lembert Sutures Closing a Wound of the Intestine: _ **A, b, b,** Marginal sutures of the outer coats _ (or penetrating sutures of all the coats); _ **c,** reinforcing Lembert sutures. **D,** The wound closed, showing the four outside Lemberts, tied.

Simple transverse wounds are closed in the same manner as longitudinal ones just described.

In irregular wounds, and where excision is not indicated, if the wound consists of a transverse and longitudinal wound (the two arms crossing each other at a right angle or diagonally) and not too extensive, the part of the transverse wound on one side of the longitudinal wound may sometimes be first closed with interrupted Lembert sutures _ then similarly the part of the transverse wound on the other side _ then the entire length of the longitudinal wound by interrupted Lemberts placed transversely to its length. (See Fig. 3837.) Sometimes, where narrowing is feared, the two parts of the transverse wound and the ends of the longitudinal are closed as just described _ and then the remaining portions of the sides of the longitudinal are sutured after the fashion of suturing the intestine in Enteroplasty for Stricture. (See

Comment.) Such an irregular wound as that made by a bullet, if not too large, may be treated as an ordinary wound, being sutured with Lembert sutures in such a way as to infold its margins. Sometimes the ragged edge of a bullet wound may be advantageously trimmed with curved scissors before suturing.

Where destruction has been great, however, or the wound very complicated, resection of a portion of the intestine, followed by some form of intestinal anastomosis, is generally safer. Complete transverse division of the intestine will necessitate an end-to-end anastomosis by means of a simple suturing or by some mechanical device. Contused wounds, if at all bad, should be treated as lacerated wounds, as the walls of such wounds are rendered of lowered vitality by the traumatism. The contused surface is thus turned into the lumen of the gut by Lembert sutures, where, if sloughing of the portion within the line of sutures occurs, no harm is done.



Figs. 3835 and 3836.—Juvara's Method of Suturing Small Wounds of the Intestine: _ A, Application of the crossed mattress-suture; _ B, the same, tied.

The injury to the intestine having been repaired, the abdomen is closed as in median abdominal section, with or without drainage, as indicated by circumstances.

Comment.—Lembert or Halsted interrupted sutures are generally employed in suturing intestinal wounds.

If any doubt exist as to the efficiency of the first row of sutures, a second tier, generally continued Lembert, may be put in, burying the first.

Areas of suspicious suturing may be strengthened by suturing over them omental grafts (elliptic pieces taken from the omentum followed by suturing up the lips of the wound thus made in the omentum) _ these are applied over the intestinal suturing and held in place by two or three gut sutures.

Resection, followed by an entero-enterostomy, is preferable to any form of suturing if by such form of simple suturing the lumen of the gut will be reduced to less than half its diameter.

Transverse suturing interferes less with the vascular supply than the longitudinal _ especially when the longitudinal is near the mesenteric border.

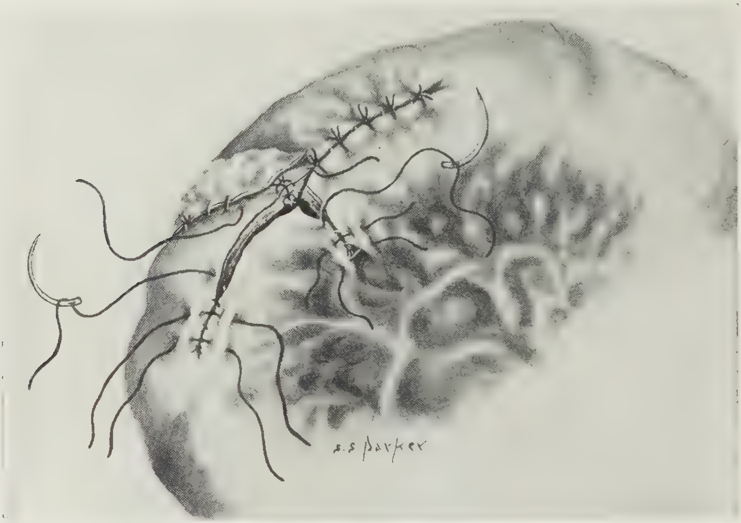


Fig. 3837.—Suturing an Irregular Wound of the Intestine; _ The two limbs of the transverse wound are first sutured by through-and-through marginal sutures, and then by Lemberts, thereby converting the wound into a single longitudinal one _ which then, in turn, is similarly sutured. This is an alternate method to partial enterectomy, followed by end-to-end entero-enterostomy _ which, in such an extensive and complicated wound, would be the method of choice. All weak aspects of such suturing _ or the entire wound _ should be reinforced by omental grafting _ as shown upon one of the limbs of the transverse cut.

A longitudinal wound of considerable length, and more or less breadth, the ordinary suturing of which might reduce its caliber too greatly, may be repaired by what is termed "elbowing" (such as is seen in the joining of segments of stove-pipes). The intestine is bent somewhat upon itself, the center of the bending being the center of the wound _ then one-half of one side of the wound is joined, by interrupted Lembert sutures, to the other half of the same side _ and the same steps are carried out on the opposite side. This is applicable only to wounds on or toward the antimesenteric border. The edges of the wound may be sometimes trimmed prior to suturing. Too great narrowing, as might result from simple suturing, or even resection, is hereby avoided.

It is sometimes safer to elliptically excise a small, ragged wound, and suture together the smooth margins. Any excess of protruding mucosa should be excised.

Comment.—In suturing some complicated wounds — or in any extensive suturing with interrupted stitches, as in some of the entero-anastomoses — it often happens that the individual sutures become confused. In such cases it is often helpful to employ Payr's special clamps (Fig. 3838) — around or between the small knobs of which the individual sutures may be temporarily parceled out, until each is ready to be taken up and tied.

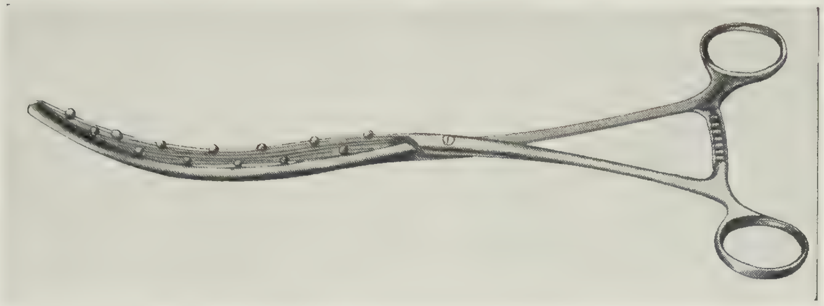


Fig. 3838.—Payr's Curved Intestinal Forceps.

OPERATION FOR ULCERATIVE PERFORATION OF THE INTESTINE

The most commonly encountered type of ulcerative perforation occurs in connection with typhoid fever — and, in the majority of instances, the perforation occurs within 30.5 cm. (12 inches) of the lower end of the ileum — and nearly always within 91.5 cm. (3 feet) of the cecum, proximally or distally to it.

The abdomen is usually opened through a median or through a right paramedian incision. The site of perforation or perforations is sought, and the involved loop or loops of intestine are brought out of the abdomen, if possible, packed off from the cavity — and clamped on each side, or not, as indicated by the leakage from the perforation.

Both actual perforations and threatened perforations are dealt with in the same way — and this is as punctured wounds of the intestine are treated — namely, either by a non-penetrating purse-string suture, reinforced by a Lembert stitch or two — or by one or two through-and-through marginal stitches of fine catgut, reinforced by two or three Lembert stitches of silk — as shown in dealing with intestinal wounds (*q. v.*).

An area through which an ulcer is about to break is treated as though perforation had already occurred — being inverted into the bowel.

In exceptional cases, especially where the ulcers are large or numerous, other measures are sometimes adopted — such as partial enterectomy, followed by entero-enterostomy (which this desperate type of patient is hardly ever able to stand) — and enterostomy.

Finally, the intestinal wall is cleansed and dropped back into place. If the peritoneal cavity has been soiled, it is cleansed by gauze wiping — or, according to some, by saline irrigation. Temporary drainage is nearly always employed in these cases.

ENTEROSTOMY, IN GENERAL

By enterostomy is understood to mean the making of an opening in the small intestine, communicating with, and fastened to the surface, and intended to functionate temporarily as an artificial intestinal opening. The term has been wrongly used as synonomous with enterotomy, which is generally accepted as signifying an opening made into the small intestine and closed at the same sitting. There is no etymologic reason why enterotomy and enterostomy should not apply to any part of the small or large intestine — but when the same techical procedures are applied to the large intestine, the terms "colotomy" and "colostomy" have been generally employed. It would be more accurate, as well as more helpful to a ready understanding, to prefix the anatomic designation of the part of the intestinal canal to the word, the ending of which implies the surgical procedure — as, for instance, duodenostomy (duodenotomy), jejunostomy (jejunotomy), ileostomy (ileotomy), cecostomy (cecotomy), appendicostomy, colostomy (colotomy) — which is often further designated as right inguinal colostomy (of the ascending colon), transverse colostomy, left inguinal colostomy (of the descending colon, anteriorly), and lumbar colostomy (of the descending colon, posteriorly) — sigmoidostomy (sigmoidotomy), and rectostomy (rectotomy).

Enterostomy, as applied to the small intestine alone, will be here considered. Colostomy will be described later (v. Index).

Enterostomy is usually resorted to as a temporary means of emptying the bowel to relieve obstruction — or to furnish nourishment, — either in emergencies requiring immediate but temporary relief — or in such cases where, while the longer need for the opening may exist, the desperate condition of the patient will not admit of some one of the more radical procedures usually performed, such as some type of colostomy, — or, again, in some cases where obstruction or other condition exists which makes difficult or impossible some preferable type of corresponding operation upon the large intestine — colostomy being, naturally, physiologically preferable to an ileostomy, where the opening is to be maintained for any length of time.

If the opening be made high up in the small intestine it may serve as an artificial mouth for nourishment (*e. g.*, jejunostomy near the stomach). If the opening be low down in the small intestine (*e. g.*, an ileostomy, low down), or anywhere in the large intestine (*e. g.*, colostomy), it will serve the rôle of artificial anus. In the last category of cases it is generally performed for some more or less permanent obstruction, the opening being, of course, above the seat of obstruction — or for the relief or treatment of disease lower down.

The manner of performing enterostomy will differ — as to whether a temporary opening is sought, which will, of its own accord, tend to close, — namely, a fecal fistula, which is generally done in some form of removable obstruction, — or whether a permanent opening is desired, which will, through a spur-like formation, tend to remain patulous — namely, an artificial anus, which is generally done in some form of irremovable obstruction. The technic of enterostomy, whether for artificial mouth, temporary fecal fistula, or permanent artificial anus, is practically the same as that for colostomy performed for temporary fecal fistula or permanent artificial anus — the chief difference being in the site of the operation.

Enterostomy (of the small intestine) is generally done upon the right side, and as near the cecum as possible. Where the operation is done for obstruction the site is, naturally, always above the obstruction. The operation may be done in the median line or upon the left side. Frequently, especially in desperate and weak cases, the first coil of distended gut is opened. A permanent artificial anus is generally made, where possible, in the course of the descending colon, a description of which is given under Left Inguinal Colostomy.

The cause having been removed, for which the fecal fistula or artificial anus has been made, it is indicated to close the opening by operation if nature does not do so.

The site of choice for opening the intestine for temporary fecal fistula or permanent artificial anus is in the colon. (See Colostomy.)

Enterostomy for nourishment is usually performed in the duodenum or in the upper part of the jejunum. Enterostomy for temporary drainage in the relief of obstruction is performed proximally to the obstruction and as near to it as possible.

Indications for Enterostomy.—(*a*) For artificial nourishment, in some cases where food cannot be taken by mouth, _ (*b*) For the direct administration of drugs, or therapeutic measures, in rare cases, _ (*c*) In some unusual cases of prolonged or repeated intestinal distention, involving the power of the bowel to contract, _ (*d*) As a means of temporary drainage in partial or complete obstruction below the site of the enterostomy _ the chief indication, _ (*e*) As a temporary fecal fistula, until the local or constitutional condition will admit of the removal of the offending cause, or the performance of a more radical or more ideal operation, _ (*f*) As a permanent fecal fistula, where the local or constitutional condition may contraindicate any other more desirable procedure

Varieties of Enterostomy.—Enterostomies (of the small intestine) may, in the first place, be divided into: _ Those for the establishment of a temporary fecal fistula _ and _ those for the establishment of a permanent artificial anus, _ and, as to site, of the duodenum, jejunum, or ileum _ the duodenum, or the uppermost part of the jejunum, being the best site for an opening planned for nourishment _ and the lower part of the ileum for an opening planned as a more or less permanent artificial anus (unless special conditions necessitate its being placed higher, to be above the site of involvement).

RIGHT INGUINAL ENTEROSTOMY (OR ILEOSTOMY) FOR THE ESTABLISHMENT OF A TEMPORARY FECAL FISTULA OF THE SMALL INTESTINE

Description.—The attachment of a coil of the lower ileum to the abdominal wall in the right inguinal region, followed by an incision into its lumen, to allow of the escape of its contents. An incision is made in the right inguinal region, and the first distended coil of small intestine above the cecum is usually drawn out and attached to the abdominal wall on a level with or but slightly projecting above its surface. No attempt is ordinarily made to remove the cause of obstruction in the emergency class of operation as the procedure often is. The opening is meant to be but temporary, and if it does not close spontaneously, it is closed by operation subsequently. If the cause of the condition calling for the operation be removable, and the patient's condition permit, the source of the trouble is corrected at the one operation.

While the above site is preferable, and an intramuscular type of operation desirable, the circumstances of the special case may indicate the greater desirability of the median line, or some other situation for the approach _ of paramount importance, of course, being the opening of the bowel proximal to the site of obstruction, if this, the usual condition, be the cause of the operation.

Preparation.—As for median abdominal section.

Position.—Patient supine, with right side near edge of table. Surgeon on side of operation _ Assistant opposite.

Landmarks.—Outer portion of Poupart's ligament; deep epigastric artery.

Incision.—About 5 to 7.5 cm. (2–3 inches) (according to the thickenss of the abdominal wall) _ placed about 4 cm. (1½ inches) above and parallel with the outer part of Poupart's ligament, and external to the deep epigastric artery.

Operation.—Having followed the steps of the intramuscular incision of the abdominal wall (p. 121), and retracted the lips of the wound, the cecum is sought with the finger and located as a rallying-point. The site of the obstruction is then located if possible, and, if so, the first distended coil of intestine above the obstruction is caught and brought into the wound. Where the source of obstruction cannot be found, any distended coil of intestine is taken and brought forward (which will probably be a portion of the lower ileum). In bringing the gut forward into the wound its normal relations and direction should be maintained as far as possible — and only its convex, antimesenteric aspect should project from the wound, but this aspect should well fill the portion of the wound to be left open, and any excess of intestine from above should be returned to the cavity that the upper part may not sag down upon the lower

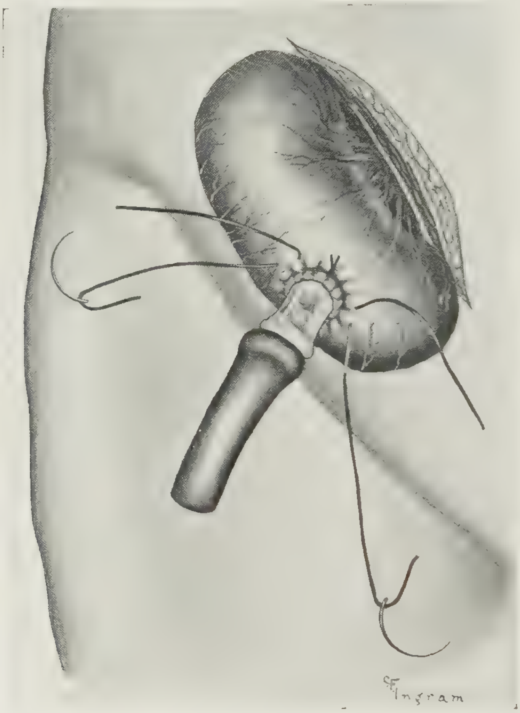


Fig. 3839.—Right Inguinal Enterostomy (or Ileostomy) for the Establishment of a Temporary Fecal Fistula of the Small Intestine — Aided by the Use of a Paul or a Mixter Glass Tube, with Rubber Connection — I; — A loop of intestine has been delivered — the glass tube tied into the intestinal opening by purse-string suture — and two initial sutures through the outer coats of the intestine, ready to anchor the returned loop to the margin of the lower plane of the abdominal wound.

The excess of length of the wound is now closed from either end either by through-and-through suturing of all layers with silkworm-gut or silk, or by layer suturing with chromic gut. The following steps of the operation will differ, according to whether the bowel must be opened at once or delay is admissible.

(*a*) **Where the Bowel Must Be Opened at Once.**—In such instances probably the best procedure is the following: The loop of intestine is delivered outside of the abdomen and its contents "milked" away from a central point, after which a clamp is applied on either side. While holding the antimesenteric aspect of the site in convenient position, and after packing off the region against soiling which may occur during the subsequent steps, a purse-string suture of silk, of elliptic contour, is carried through the outer coats of the bowel, calculated to surround an opening to be made into the intestinal lumen proportional in length to the diameter to be used. The incision is then made through the walls of the intestine – and an angular, flanged glass tube, of the Paul or Mixter type (preferably a tube with a fenestrum in its elbow), and with a long rubber tube attached to its free end, is at once inserted into the intestine – which is then tied by means of the purse-string around the neck of the tube – carefully avoiding all unnecessary leakage (Fig. 3839). The clamps are then removed, and the liquid and gaseous contents of the intestine evacuated at a distance through the attached tube. Finally, the loop of intestine is attached to the abdominal wound by means, at first, of a suture at each end, and then by as many intervening sutures as may be considered necessary (Fig. 3840). These sutures may be of silk or catgut, and pass through the outer coats of the intestine, and through some of the tissues of the lower plane of the abdominal wound, especially inclusive of the parietal peritoneum and subserous areolar tissue. The loop of intestine may be anchored in the wound before the excess of the wound at each end is closed if more convenient. The loop does not protrude above the wound level. Figure 3841 shows the technic in section.

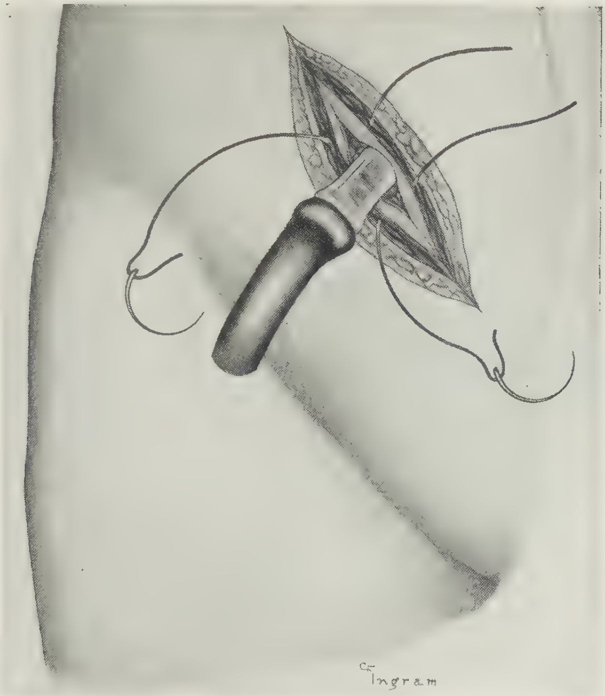


Fig. 3840.—The Same – II; – The intestinal loop is being anchored to the parietal peritoneum and adjacent tissues of the lower plane of the abdominal wound

(*b*) **Where the Bowel Need Not Be Opened Immediately.**—It may be stitched to the parietal peritoneum, transversalis fascia, and lower plane of the abdominal wound _ with its surface on a level with the lower plane of the wound _ the excess of which is closed in from both ends down to the site of the anchored bowel (Fig. 3842). Time is given for the peritoneal union of the bowel to the margins of the wound _ two or three days, if possible _ but even two hours will accomplish some degree of shutting off of the peritoneal cavity. After a reasonable interval has passed (and if this can be delayed until the abdominal wound is fairly united, so much the better), the presenting coil of intestine is incised axially, and the contents allowed to escape upon abundant dressings of gauze _ the neighboring margins of skin being protected by sterile vaselin or rubber and benzin solution.

Comment.—The operation may be performed through a median or other incision _ or the obstruction may be located through a median incision and enterostomy done through a lateral incision _ thus giving greater room for diagnosis and possibly for correcting the cause of trouble _ the excess in length being closed in at either end before attaching the intestine. Left inguinal enterostomy may also be done.

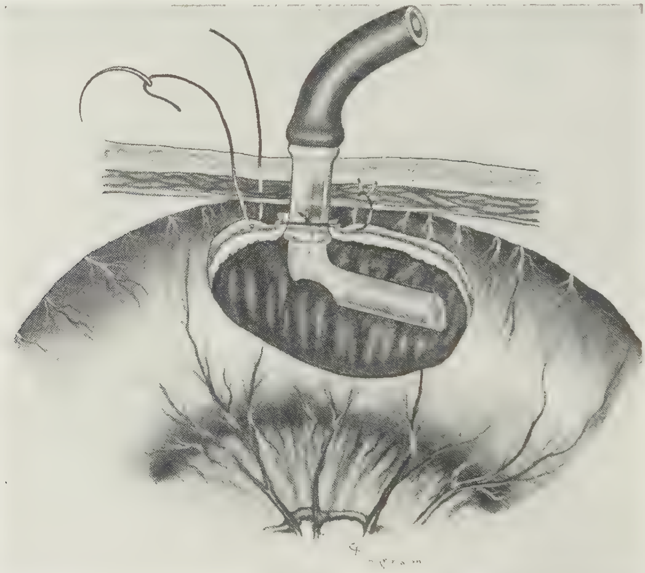


Fig. 3841.—The Same _ III; _ Sectional view of the preceding steps.

Avoid wounding the deep epigastric artery and twisting the gut.

As small an opening as consistent with efficient emptying should be made, to make the subsequent closing easier.

The incision into the intestine is best made by a controlled stab cut by knife, subsequently extended by scissors. Or the intestines may be ridged up between the grasp of two pairs of forceps and cut with scissors.

Sometimes, after opening the intestine, the contents are first emptied by means of a special tube, before anchoring the loop of intestine in the abdominal wound.

One of the indications for temporary enterostomy is for transient drainage of infective intestinal contents, as in ileus and peritonitis, to avoid the serious toxemia from absorption of intestinal contents undergoing decomposition, often resulting in the distention of the intestinal walls. The patient can, in toxic collapse, often only stand the simplest form of immediate enterostomy. Into such openings concentrated solutions of laxative salines are sometimes injected _ as well as atropin and physostigmin. Such operations are often performed under analgesia.

It may be impossible, because of adhesions, to draw a loop of intestine out of the abdominal wound _ and, in such cases, one has no alternative, but must anchor the presenting part of the small intestine in the lower plane of the abdominal wound and then incise it _ the incision being made immediately, or within a short time _ which is less desirable than drawing off the intestinal contents by means of combined glass-and-rubber tubage. Such technic, however, may be optionally chosen.

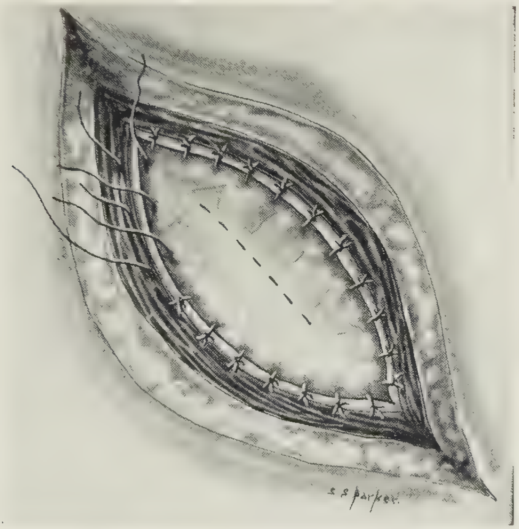


Fig. 3842.—Right Inguinal Enterostomy (or Ileostomy) for the Establishment of a Temporary Fecal Fistula of the Small Intestine _ Where the Intestinal Loop Cannot be Delivered Outside of the Wound, or, Independently, is Anchored Into the Lower Plane of the Abdominal Opening Before Being Incised; _ The outer coats of the bowel are sutured into the lower structures of the margin of the abdominal wound, outlining an elliptic area _ into the center of which an axial incision will be made as soon as adhesions shut off the peritoneal cavity.

Before the glass tube (where the tubage technic is carried out) has become loose, from the cutting out of the sutures, adhesions will have shut off the peritoneal cavity.

The suture of the outer coats of the intestine to the parietal peritoneum alone does not offer sufficiently secure anchorage _ but must include, additionally, some more resistant tissue overlying the peritoneum (according to the site of operation).

The glass tube tied in the intestinal opening is due to loosen in from two to five days, but an additional ligature tied around the slackening opening will keep the wound clean for two or three days still longer.

If the skin surrounding the wound be painted, from the first, with a saturated solution of pure rubber dissolved in benzine, its excoriation by acrid discharges will be minimized.

The lower the plane of the wound into which the intestine is sutured, the more readily will the resulting fecal fistula close spontaneously, when its patulousness is no longer needed – and, on the other, the nearer the level of the skin into which it is anchored, the greater the difficulty, the greater the narrowing of the restored intestine, and the longer the time of spontaneous healing.

As there is marked tendency for the portion of the small intestine below the site of the enterostomy to form adhesions, which are often most difficult to deal with, and which are sometimes obstructive, the cecum is preferred by some Surgeons as the site of artificial opening (cecostomy). Again, an appendicostomy (q. v.) may sometimes take the place of an enterostomy.

In opening the bowel for drainage in intestinal paresis, in moribund patients, only the simplest, quickest procedure, under analgesia – and without intra-abdominal examination, or other procedure – is often all that is permissible.

Spontaneous drainage, rather than irrigation, is the technic usually adopted following the making of the intestinal opening – certainly when the opening is first made.

The special forms of enterostomy, as applied to the duodenum and jejunum (v. Duodenostomy and Jejunostomy), where the matter of nourishment is a consideration, will be taken up later.

ENTEROSTOMY FOR THE ESTABLISHMENT OF A MORE OR LESS PERMANENT ARTIFICIAL ANUS OF THE SMALL INTESTINE

Description.—Enterostomy for the establishment of a more or less permanent artificial anus differs from enterostomy for temporary fecal fistula, in that the former is performed in cases where the obstruction is irremovable, or where the opening is required for some length of time – and also where it is sought to prevent the passage of intestinal contents into the limb of the bowel below the opening. The typical operation of enterostomy for the establishment of a permanent artificial anus is seen in the operation of Colostomy (as performed for inoperable obstruction of or treatment of the large intestine). The operation to be here considered is simply an application of those principles to cases of the small intestine, where, upon opening the small bowel above the seat of obstruction, it is found the opening must be more or less permanent. It is even of greater importance, for nourishment, that a permanent artificial anus of the small intestine should be lower down than a temporary fecal fistula. It is well to follow the intramuscular manner of abdominal incision, where possible – both as a guard against hernia and for gaining some degree of a sphincteric control of the intestinal opening. The only practical difference between this and the preceding operation is in the manner of attaching the knuckle of intestine to the abdominal wound – so as to produce, on a small scale, the spur-like formation sought in colostomy.

Operation.—The early steps of the operation are the same as when a temporary fecal fistula is to be made (p. 653). When the knuckle of bowel to be drawn into the wound is isolated, it is important, and necessary, to determine which is the proximal part of the coil. This having been done, and the knuckle having been drawn into the wound, the excess of intestinal length which tends to sag down into and out of the upper angle of the wound, is taken up and passed on down through the lower angle of the wound (so as to do away with the likelihood of future hernia of the proximal limb of the intestine through the wound). When the portion of intestine is finally located with which it is intended to deal, it is grasped with intestinal forceps, for the purpose of holding it in the field, and to aid in manipulating.

The same considerations now arise, as in the case of establishing a very temporary fecal fistula, just described – namely, as to whether a glass tube, of the Paul or Mixter type, be introduced into the lumen of the intestine, which also means that the intestinal contents are immediately evacuated before the anchorage of the intestine to the margins of the abdominal wound – or whether the loop of intestine be first anchored in the wound and the intestinal incision and evacuation made as soon as adhesions have shut off the general peritoneal cavity (unless necessity demands immediate opening, following anchorage). These points are to be determined just as they are decided in the preceding operation.

Irrespectively of these considerations, however, and independently of which may be adopted, a sufficient loop of intestine is brought out and anchored in the wound to insure, on a smaller scale, such a spur formation as is sought in colostomy – for the purpose of a longer maintenance of the patulous opening.

The knuckle of intestine is now drawn entirely out of the wound, until the mesenteric attachment is just below, or on a level with the skin. Care is taken that the intestine is not twisted, and that the normal relations are retained, as nearly as possible. Care is also especially taken that the proximal limb of the loop is identified and kept uppermost in the wound, is given plenty of room in the opening, and that it is made to somewhat compress the distal limb against the lower angle of the wound (to prevent the passage of intestinal contents from the proximal into the distal limb). While held in this position, the knuckle of intestine is sutured into the abdominal opening, so that the convex aspect of the bowel is somewhat above the level of the skin. This suturing is accomplished by non-penetrating catgut (or silk) stitches, passed through the outer coats of the bowel, on the one hand, and, on the other, through the parietal peritoneum, subserous areolar tissue, and the lower plane of aponeurotic or muscular tissue forming the wound margin (Fig. 3843). The two serous surfaces must be everywhere in contact for an appre-

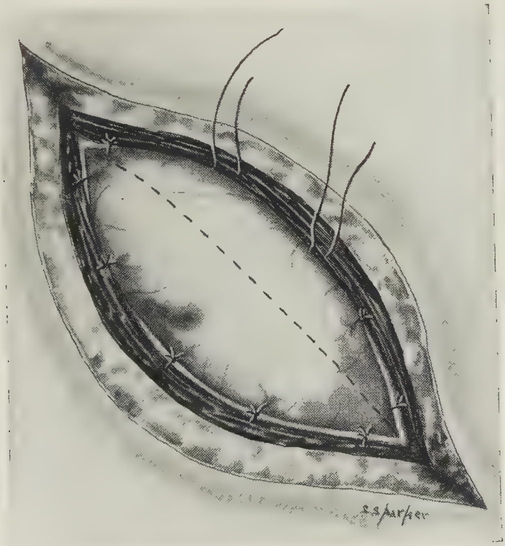


Fig. 3843.—Enterostomy (Right Inguinal Ileostomy) for the Establishment of a More or Less Permanent Fecal Fistula of the Small Intestine – I; – The loop of the lower ileum sutured into the abdominal wound

ciable width. Whatever excess of abdominal wound there may be present is previously closed in from one or both ends, by tier suture, or by through-and-through suture.

If the technic have included the preliminary anchorage into the intestinal loop of a glass tube, with connecting rubber tube, provision will have been already made for the evacuation of bowel contents. If, on the other hand, the bowel have been merely stitched into the abdominal opening, as just described — and if no haste exist — the incision of the intestine is deferred for two or three days, until serous adhesions have occurred. If haste be necessary, the opening may be made at once — although safety against leakage into the peritoneum will be greatly increased by the delay of even two hours — and, preferably, six hours, if possible. Finally, an axial incision is made through the walls of the bowel — after which the margins of the intestinal opening are sutured into the margins of the abdominal wound — either to the skin itself, or to some portion of the wound margin between the level of peritoneum and skin. A subsequent operation for closure of the fistula and restoration of the intestine, when the fistula is no longer needed, is necessary when the intestinal margins are sutured to the skin (Fig. 3844).

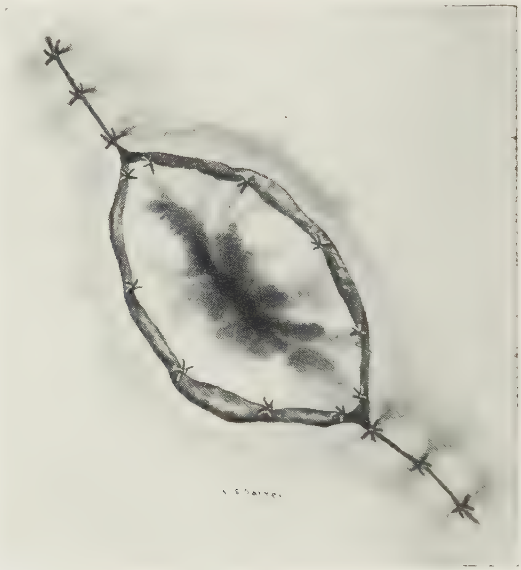


Fig. 3844.—The Same — II; — The intestine has been axially incised and the margins of the intestinal wound sutured to the margins of the skin, or just below the margin.

The skin in the neighborhood of the opening should be smeared with sterile vaselin, or painted with a saturated solution of pure rubber in benzine, to prevent excoriation.

Comment.—This, as well as the temporary form of fecal fistula, may be made in the median, or left lateral regions, either in the site of an original median incision, or independently of such original incision — but, when performed for obstruction, it is even more important than in temporary fecal fistula that the opening be as low as possible, to prevent starvation — while, as a means of supplying nourishment artificially, it should be as near the opposite or proximal end of the intestine as possible.

A glass rod may be run through the mesentery of the loop, as is sometimes done in colostomy — to hold the coil of intestine in place.

In order to form a more marked spur, the two limbs of the intestinal loop may be stitched together for 5 to 7.5 cm. (2–3 inches) — as also sometimes done in colostomy — before anchoring the loop in the abdominal wound. This technic also prevents an adjacent knuckle of intestine from slipping in between the proximal and distal limbs of the loop and thus obviates the possibility of wounding such an intervening piece of intestine, when, subsequently, an enterotome may be used to destroy the spur.

When it is necessary to open the intestine immediately, sometimes a very limited opening is then made, simply to allow the relief of gaseous or liquid distention — and this opening is, later, increased.

Sometimes the parietal peritoneum is sutured to the skin — and then the intestinal loop anchored to this.

Care is required, during suturing, not to penetrate the lumen of the intestine — as leakage and infection may occur through the needle wounds.

Sometimes, instead of first tying a glass tube into the intestinal opening, before making the anchorage of the intestinal loop, the order may be reversed and the glass tube still be used. But this is usually not possible if the intestinal coil be so anchored as to present a flat surface, and be on a very low level in the wound. If it be contemplated to use a glass tube, then the loop that is anchored should be somewhat more redundant, and more protrudant from the wound. The preliminary placing of the glass tube, however, is probably preferable.

As the contents of the small intestine are liquid, a smaller glass tube may be used than is required in colostomy. Indeed, a medium rubber tube or catheter may be employed.

In passing any form of intestinal tube into the intestinal opening, two points are of very practical bearing: — That the drain should not pass in far enough to impinge upon the opposite intestinal wall and be blocked thereby, — and that a tube passed for drainage should certainly pass into the proximal limb — while a tube passed for nourishment should certainly pass into the distal limb (if the intestinal opening be made high up in the course of the small intestine).

All tension of or upon the anchored loop of intestine should be avoided.

What has been written of the temporary type of fecal fistula should be read in connection with the more or less permanent type of fecal fistula, and vice versa.

Further, what has been said in connection with these two operations in the region of the ileum is, largely, of general application to intestinal fistulæ. There are, however, special applications of this technic — which may be summarized as follows: — more or less permanent openings for nourishment are usually made in the duodenum or jejunum, — temporary openings for evacuation and drainage are generally made in the ileum, just proximal to the obstruction, — while more or less permanent artificial ani are ordinarily made in the colon. Therefore, special forms of enterostomy will be considered under duodenostomy (p. 661) — jejunostomy (p. 662) — and colostomy (q. v.).

DUODENOSTOMY

An artificial fecal fistula between the lumen of the duodenum and the surface of the skin constitutes a special type of enterostomy — the principles of which have just been described. In theory, the duodenum is the most desirable part of the intestine to select for making a fistulous opening planned for nourishment _ owing to its nearness to the source of supply of gastric, pancreatic, and biliary secretions. And it is possible, mechanically, to attach the duodenum to the abdominal wall, even without its mobilization (which is sometimes resorted to for the purpose).

Owing, however, to the greater difficulties technically _ and especially because of the difficulty of preventing the escape of the biliary and pancreatic juices upon the neighboring skin surfaces _ coupled with the fact that, practically, jejunostomy has proved a very satisfactory and easily carried out procedure, the latter operation has become the method of choice in making an artificial intestinal opening in the upper part of the canal, for the purpose of nourishment

JEJUNOSTOMY

Description.—An artificial fistulous opening between the upper part of the jejunum and the surface of the skin, constitutes another special type of enterostomy _ the general and special features of which have been described in the immediately preceding pages. The procedure may be regarded as the typical operation for the etsablishment of a nourishment-receiving intestinal fistula _ and as the operation of choice for this purpose.

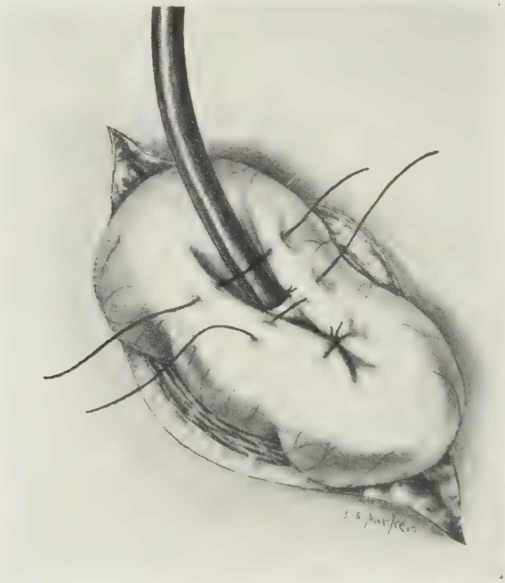


Fig. 3845.—Jejunostomy by the Eiselberg-Witzel Method _ I; _ Burying the tube in the wall of the jejunum.

In a general way, it may be said that jejunostomy is the best procedure to be adopted in those somewhat unusual cases of complicated or advanced gastric malignancy and pyloric obstruction, in which neither gastro-enterostomy, nor gastrostomy seems wise, or possible of performance. The more definite list of conditions under which jejunostomy is indicated is given in the following paragraph.

Indications.—(*a*) Those cases of malignancy of the esophagus, or stomach, in which both gastro-enterostomy and gastrostomy are considered unjustifiable, or impossible; _ (*b*) Where the stomach has been too much injured by destructive fluids accidentally swallowed to make it safe to immediately continue the use of the stomach for food; _ (*c*) To secure temporary physiologic rest for the stomach in some cases of ulcer, hemorrhage, and functional disease; _ (*d*) In cicatricial contraction of the stomach, resulting from corrosive poisonings; _ (*e*) Pyloric stricture; _ (*f*) As a preliminary to certain operations upon the esophagus and stomach.

The chief methods of performing jejunostomy will be described.

Jejunostomy By the Eiselberg-Witzel Method.—The jejunum is exposed by a median, or left paramedian incision _ and, at a point from 30.5 to 40.5 cm. (12–16 inches) from its beginning, an incision is made through its antimesenteric wall, large enough to receive a No. 9 (English) rubber catheter _ which is passed into the intestinal lumen until it has traveled for about 7.5 cm. (3 inches) distally. A single chromic catgut suture passing through the walls of the small intestinal incision, and into but not through the wall of the rubber tube, holds the latter in position until the suture is dissolved. While the catheter slightly depresses the wall of the bowel, the outer coats of the intestine are infolded over the rubber tube by Lembert, or mattress-sutures _ in exactly the same manner as the rubber tube is buried in the wall of the stomach in Witzel's gastrostomy (Fig. 3845). Finally, the bowel is anchored to the parietal peritoneum of the lower angle of the abdominal wound, by two or three sutures (Fig. 3846) _ after which the abdominal wound is either closed down to the exit of the tube _ or the tube is brought through a small incision made through the abdominal wall to one side of the abdominal section, the bowel being anchored to the parietal peritoneum there by two or three sutures, and the main wound completely closed. The Mayos use linen thread in the suturing.

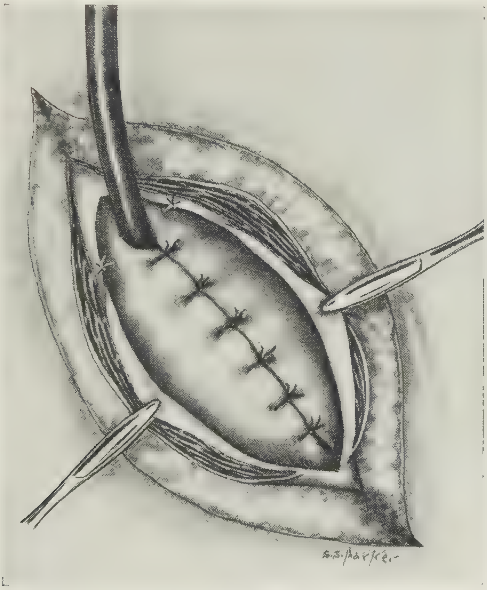


Fig. 3846.—The Same _ II; _ Anchoring the jejunum into the abdominal wound.

A sectional view of the technic is seen in Fig. 3847.

To locate the upper part of the jejunum, after displacing the inner margin of the rectus to the left _ carry the left index-finger under the transverse colon, to the left of the second lumbar vertebra, and hook up the beginning of the jejunum and bring it out of the abdominal wound.

The infolding suturing is carried somewhat beyond the incision in the bowel. The tube should make its exit on about the level of the umbilicus _ and is sutured to the parietal peritoneum in such a way as to lie transversely to the abdominal wound.

This technic is simple and can be quickly applied, especially in cases not capable of standing a prolonged technic.

Mayo-Robson's Jejunostomy.—A loop of the beginning of the jejunum, long enough to reach the surface without tension, is drawn into the wound. The two limbs of the bowel are anastomosed laterally at 7.5 to 10 cm. (3–4 inches) from the surface of the abdomen _ either by simple suture or by sutures applied around a decalcified bone-bobbin. At the top of the knuckle of bowel an incision is made just large enough to admit a No. 12 Jaques catheter _ which is then carried through this opening and for about 7.5 cm. (3 inches) down the distal limb of the intestinal loop _ and is fixed to the margin of the intestinal incision by a single stitch of silk or linen _ after the entrance of the tube into the intestine is guarded by a double purse-string suture, one over the other (Fig. 3848). The top of the bowel-loop is then sutured to the skin by one or two sutures, and the abdominal wound closed. The patient can be immediately fed peptonized milk and brandy through this tube.

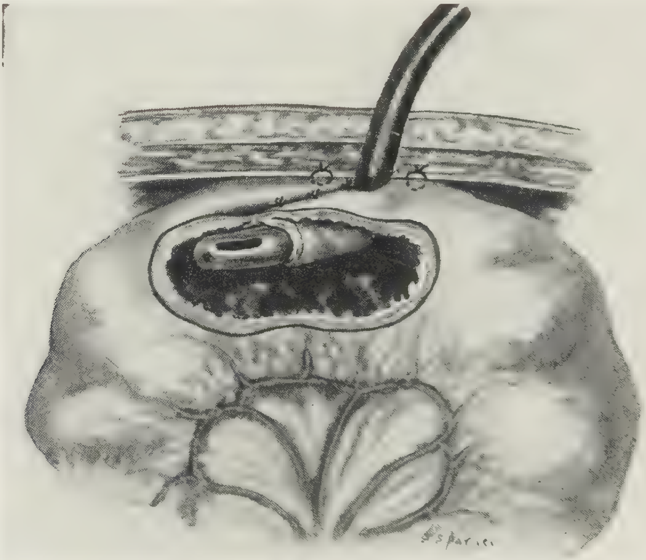


Fig. 3847.—Jejunostomy Upon the Witzel Principle _ Sectional view. (The tip of the tube here does not correspond with that in the preceding illustration.)

If the patient's condition forbid the taking of time for the lateral anastomosis, this step of the operation may be omitted _ in which cases, instead of bringing the top of the bowel-loop to the skin level, it is sutured to the margin of parietal peritoneum and aponeurosis

Robson's operation has, in common, the principle of the Albert operation, where the loop of jejunum is drawn through the split fibers of the rectus muscle, its base is attached to the parietal peritoneum.

Maydl's Jejunostomy.—The abdominal cavity is opened through the left rectus muscle, or a left paramedian incision is made and the left rectus retracted outward; after which the upper end of the jejunum is sought and delivered in the same manner as described under the Mayo operation. Two clamps are applied and the upper end of the jejunum is divided at a level between 20 and 25 cm. (8 and 10 inches) from its beginning; the section passing 10 to 12.5 cm. (4–5 inches) through its mesentery (to give the ends free play). After drawing the lower end of the jejunum well out of the abdominal cavity, a third clamp is applied to this part of the intestine about 15 cm. (6 inches) from its end; and just above this an incision is made through the antimes-

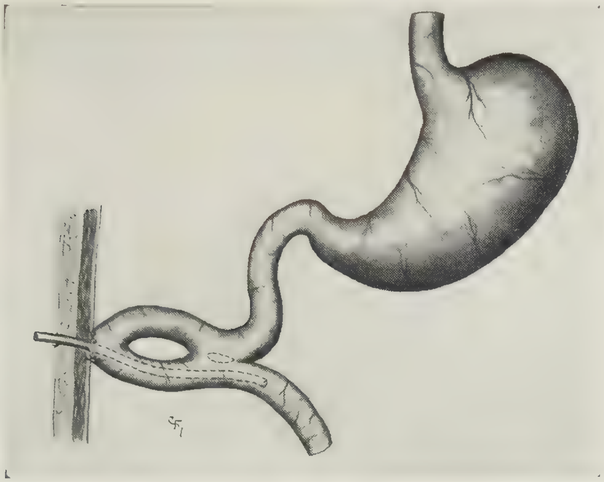


Fig. 3848.—Mayo-Robson's Jejunostomy.

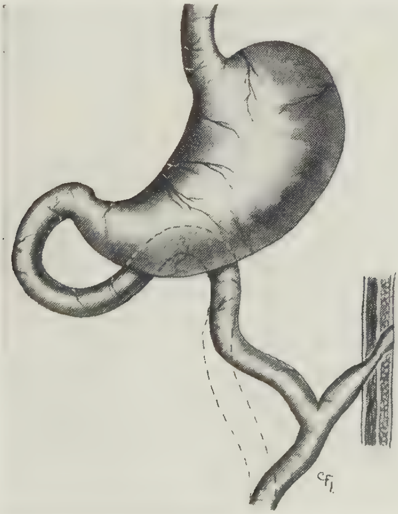


Fig. 3849.—Maydl's Jejunostomy.

enteric aspect of the bowel about 3 cm. (9¼ inches) in length. Into this lateral opening the free, lower end of the proximal portion of the jejunum is implanted (end-into-side entero-anastomosis). The upper, free end of the distal part of the jejunum is then anchored into the abdominal wound in such a manner that the free end projects about 2 cm. (¾ inch) beyond the skin. This projecting intestinal end, finally, may be drawn, in an oblique course, through the separated fibers of the right rectus muscle. The technic is suggested in Fig. 3849.

By this clever procedure not only are the bile and pancreatic juices kept from excoriating the skin, but they are saved for intestinal digestion. The fistula is planned to be permanent.

This operation is the method of choice, among those here mentioned, according to the judgment of many _ provided the patient's condition will tolerate the more complicated and prolonged technic.

PARTIAL ENTERECTOMY AS A PRELIMINARY TO INTESTINAL ANASTOMOSIS

Description.—By partial enterectomy is meant the excision of part of the intestinal canal (from a few centimeters, or inches, up to several meters, or feet) _ with or without the simultaneous excision of the corresponding portion of the mesentery. The excision does not constitute an operation in itself _ but is invariably followed by some form of anastomosis between the remaining proximal and distal ends of the intestine. The method of excision is here described alone, as there is, practically, but one way of making the excision, whereas there is a multitude of methods of making the anastomosis _ so that when the subject of intestinal anastomosis is taken up, the details of the preceding excision will not have to be dealt with in each case.

By prefixing the name of the part of the canal the site of the partial excision is designated _ Partial Duodenectomy, Jejunectomy, Ileectomy, Cecectomy, Colectomy (ascending, transverse or descending), Sigmoidectomy, Rectectomy. By the term "Enterectomy" alone is usually understood an excision of some part of the small intestine. As, of course, excision of the whole intestine is never considered, Enterectomy is generally used in the sense of a partial excision, without the preceding word "partial." Enterectomy carries with it the idea of three operations _ partial excision of the intestine _ partial excision, or incision, of the mesentery _ intestinal junction. The operation is generally resorted to where the disease or injury to a part of the intestine, or its mesentery, is so extensive that a portion of the intestine must be cut out and sacrificed.

Preparation _ Position _ Landmarks _ Incision.—Dependent upon the nature of the case and the operation in question.

Operation.—Having opened the abdomen, the portion of intestine involved is brought out into the field of operation. Before excising any portion of the intestinal tract the contents of that part should be removed from it as much as possible _ which is best accomplished by "milking" the intestines in opposite directions from a central point, the center of the part to be excised _ and then clamping the intestines, proximally and distally, beyond the site to be removed. Various forms of clamps are used for this purpose, which may be divided into three categories: _ (*A*) Special intestinal clamps, which are generally best (Figs. 3850 and 3851); _ (*B*) Improvised clamps may be used, such as: (*a*) Pierce the mesentery near the intestinal border with the closed ends of a pair of forceps - grasp a small rubber tube in the bite of the forceps and draw it through the mesentery _ and tie the two ends over the intestine; (*b*) Pass a sterilized wooden toothpick through the mesentery, near the intestine, and make a figure-of-8 with a rubber band over it, compressing the intestine between toothpick and rubber band; (*c*) Pass the pin of a safety-pin through the mesentery, near the intestine _ and fasten, in the act of closing the pin, a small piece of flat sponge over the intestine; (*d*) Pass a piece of gauze through the mesentery, near the bowel, and tie over the intestine after the fashion of the rubber tube in (*e*) above; _ (*C*) The thumb and index of each hand of an Assistant may be used to compress the intestine in the position a pair of clamps would occupy _ after having pressed away the intestinal contents.

The mesenteric vessels are now ligated (see Comments) just proximal to the site along which will fall the line of mesenteric excision.

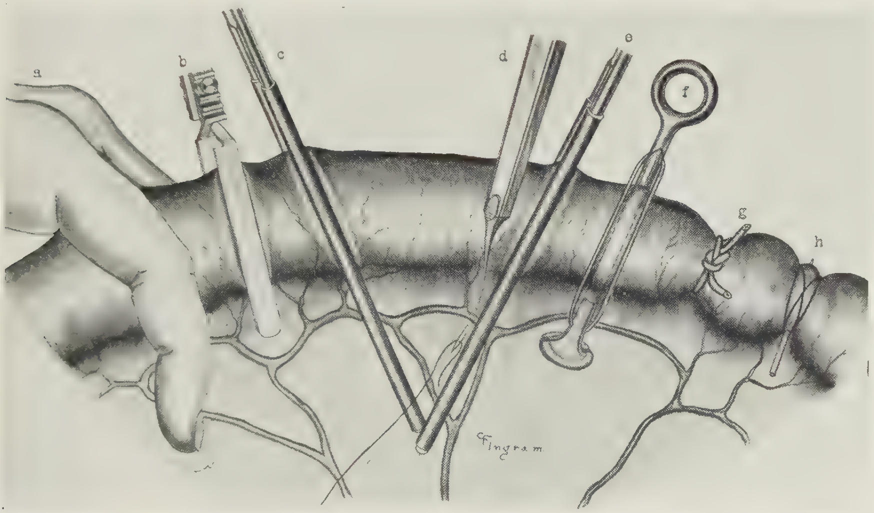


Fig. 3850.—Methods of Controlling the Intestines and Adjacent Mesentery and Vessels, During the Performance of Partial Enterectomy _ Preliminarily to Intestinal Anastomosis of the Intestinal Ends: _ **a,** Digital compression _ the opposite end of the intestinal segment being similarly compressed; _ **b,** compression by clip-clamps; _ **c, e,** the limits of the intestinomesenteric segment is compressed by ordinary clamps, converging to their tips; _ **f,** Lane's clamp-forceps (in detachable parts and rubber-band connector); _ **g,** constriction by rubber cord; _ **h,** compression of the intestine by a small rubber band, wound, figure-of-8 fashion, around the ends of a sterile wooden toothpick; _ **d,** Reverdin needle, underrunning the mesenteric vessels, preparatory to ligating them.

The indicated portion of the intestine is then excised _ by dividing the gut on either side of the segment to be removed, with scissors or knife, exactly at a right angle to the length of the intestine at the part divided _ so that the cut ends may be afterward approximated without any tension at either mesenteric or antimesenteric aspect (Fig. 3852). (There is somewhat greater retraction of the antimesenteric border naturally.) Division of the intestine with a knife is technically better than by means of scissors, which latter, though easier to manipulate, compress the edges somewhat. It is well to have, if possible, a good artery left just to the proximal side of the proximal intestinal incision, and one on the distal side of the distal intestinal incision _ to furnish nourishment to the uniting edges. The triangular space, at the separation of the leaves of the mesentery, will be opened up _ and care should be exercised not to bare the intestinal tube further than necessary.

The treatment of the mesentery corresponding with the excised portion of the intestine differs — one of the following methods may be used: — (*a*) Probably the best plan, after having excised the portion of intestine, or along with the excision, is to remove a triangular, or V-shaped piece of the mesentery — whose base will be a little narrower than the section of the intestine removed — whose sides will pass down obliquely toward each other in the direction of the root of the mesentery, but meeting midway between the two free ends of the intestine and before reaching the root of the mesentery. The division is made with a knife or scissors, from a line with the free ends of the divided intestines at their mesenteric borders — taking care to preserve the artery supplying the free end of the intestine, proximally and distally. In suturing, the edges of the cut mesentery are approximated with catgut by continuous or interrupted suture (Fig. 3853, A and B). Or the edges may be slightly overlapped and then sutured, uniting laterally (Fig. 3853, C) All vessels which fall along the line of division of the mesentery, whose position is shown through the thin mesentery, should be ligated, proximally in advance of the division — by passing a curved needle armed with gut, beneath them, — or the vessels may be clamped immediately after division and then ligated (see Figs. 3852–3854). This method is especially advisable in malignant disease where the mesenteric glands may be involved. (*b*) Another method is, after dividing the intestine at both

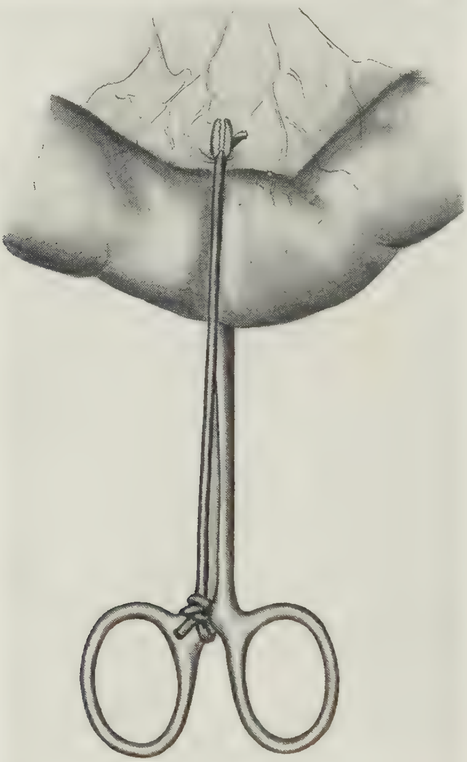


Fig. 3851.—Pean's Method of Clamping the Intestine by Means of a Hemostat and a Piece of Rubber Tubing or Rubber Cord.

ends, simply to cut away the excised portion close along the mesenteric attachment, after having ligated its vessels as in the above method. In suturing, the redundant mesentery is simply folded upon itself and a few catgut sutures passed from side to side, along the angle of junction with the rest of the mesentery, and by whipping the free margins with a catgut suture to prevent a hernia occurring through the opening. This method probably insures a better blood-supply to the intestine (Fig. 3853, D). (*c*) In addition to the steps mentioned in the last method, the entire triangular fold may

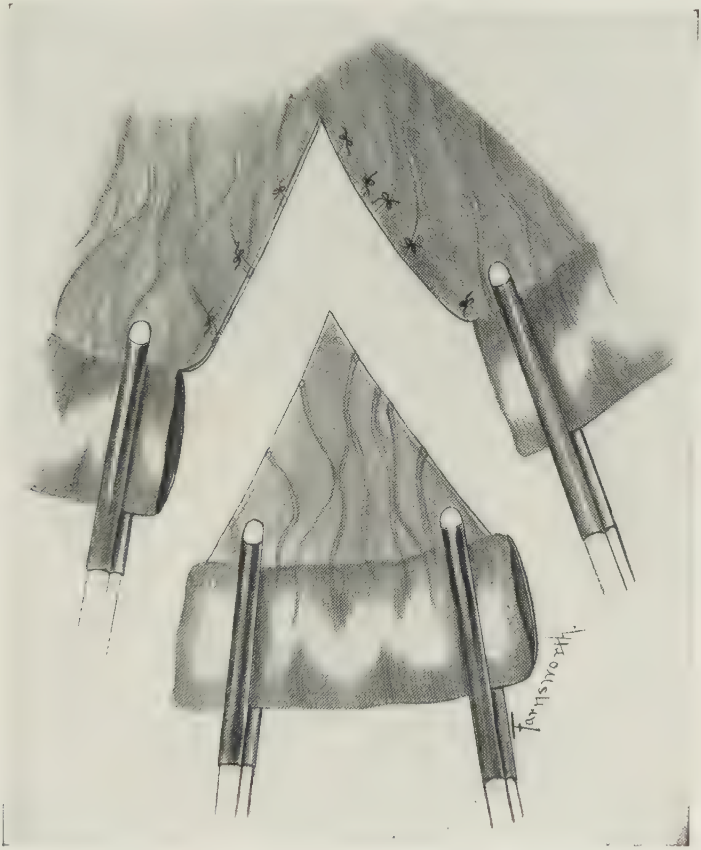


Fig. 3852.—Partial Enterectomy;—The excision of a part of the small intestine is shown, with the excision of a corresponding V-shaped portion of mesentery. The intestine is divided at a right angle to its length, between two clamps at either end of the excised area. The main mesenteric vessels are ligated prior to section.

be sutured back to the general mesentery by sutures along its folded border, as well as along its free border (Fig. 3853, E).

Comment.—Partial enterectomy is an incomplete operation in itself, as already explained, and naturally carries with it the idea of suturing together the two free ends of the intestinal canal left open after the excision, and thus repairing the intestinal tract, but since the junction of these two ends is accomplished by a separate and distinct operation, it will be treated of separately. (See Entero-enterostomy.)

The make-shift measures of bowel-control, in the several methods of clamping mentioned, are only warrantable when other means are not available. It is distinctly preferable, and more technical, that the outside clamps should be those intended to be used, following the excision, until the intes-

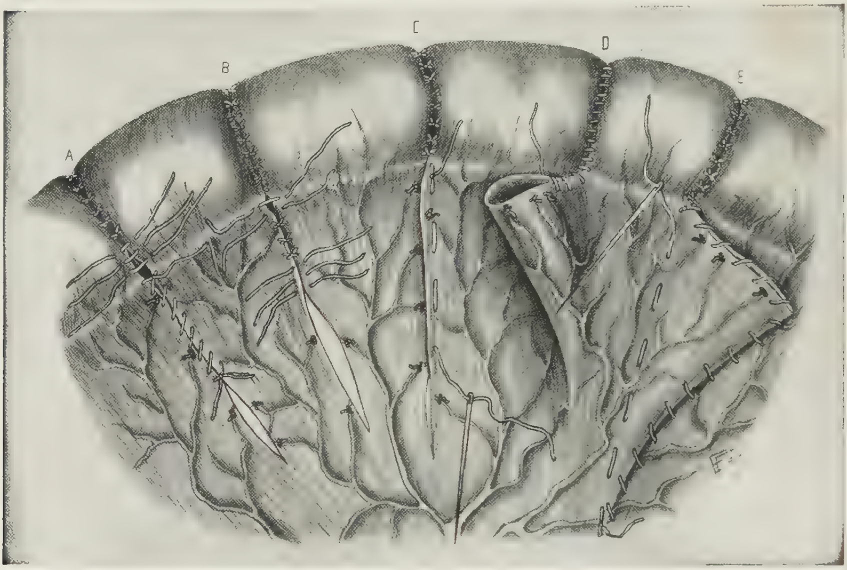


Fig. 3853.—Methods of Suturing the Mesentery in Partial Enterectomy: _ A, A V-shaped portion of mesentery excised, with suturing of edge to edge by continuous suture; B, same, with suturing of edge to edge by interrupted sutures; C, same, with edges overlapped by running suture; D, mesentery left intact, with free edges sutured together by continuous overhand stitch; E, same, with suturing of both free border and free fold of redundant mesentery to main mesentery, together with closure by continuous suture of entrance to mesenteric pocket. Note: Several mesenteric vessels are shown ligated by the passage of needle and gut ligature beneath them.

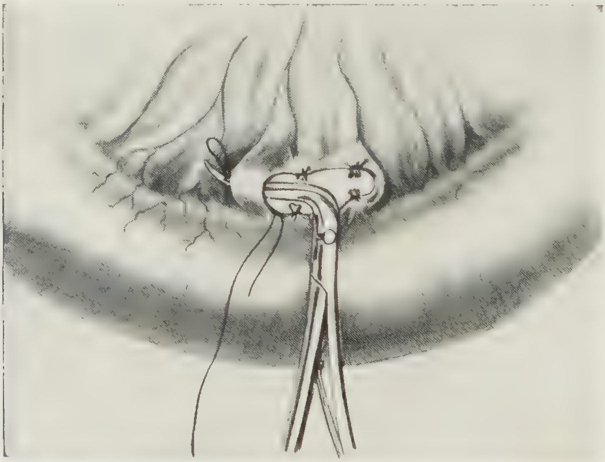


Fig. 3854.—Double Ligature of the Mesentery _ with the Cleveland ligature-carrier, preparatory to excising a segment of intestine. The proximal ligatures alone usually suffice.

tinal anastomosis is completed – as any shift of clamps after the enterectomy, and before the completion of the entero-enterostomy, is certain to be followed by some intestinal escape – and if it be planned to complete the anastomosis while the ends of the intestine are still clamped, as is generally both more convenient and more surgical, these outlying clamps should, from the first, be the permanent pair.

A Reverdin needle is an instrument with which the ligation of the mesenteric vessels can be accomplished with ease and rapidity. In using either it or an ordinary needle carrying a ligature, especial care must be exercised that the point does not penetrate a coil of intestine which might happen to be out of sight, behind the mesentery which is being underrun by the needle.

Where it is not intended to excise a triangular portion of the mesentery corresponding with the portion of intestine excised, the mesentery and its vessels can be taken up and ligated in segments, just proximal to the barrel of the intestine, by such an instrument as the Cleveland ligature-carrier – as shown in Fig. 3854. Double ligatures are here seen – but, ordinarily, a single line of ligatures (the tier here represented nearer the root of the mesentery) suffices.

Kocher has called attention to the desirability of so placing the clamps, prior to making the excision, at slight obliquity to the axis of the bowel, that a little more of the antimesenteric portion of the bowel will be removed – not enough to cause any angulation – but enough to insure a more certain blood-supply.

ENTERO-ENTEROSTOMY (INTESTINAL ANASTOMOSIS) FOLLOWING PARTIAL ENTERECTOMY

IN GENERAL

Intestinal Anastomosis was originally applied to the operation of establishing a communication between the intestine above and the intestine below the seat of obstruction, without the removal of the portion of intestine in which the obstruction was situated. As a result the larger part of intestinal contents would flow by the new route, thus "short-circuiting" the obstruction, while the smaller portion would flow through the partially obstructed canal, until the obstruction was relieved or became complete. As, in such cases, no portion of the intestine was removed, the Anastomosis was always a Lateral Anastomosis, that is, the joining of the lateral aspect of one coil with the lateral aspect of another coil. Subsequently, however, Intestinal Anastomosis came to be used, by many Surgeons, in the same sense as Intestinal Approximation, and applied to both end-to-end and to lateral joinings.

Intestinal Approximation was originally used to signify the union of the portions of the intestinal tract following the excision of a part of the canal – the approximation being either end-to-end or lateral. In End-to-end Intestinal Approximation, after the excision of a part of the intestine has been accomplished, the free ends of the intestine above and below are approximated and united. In Lateral Intestinal Approximation, after the partial enterectomy has been performed, the free ends of the intestine above and below are closed by suture, and then the lateral aspect of the closed upper end is approximated and united to the lateral aspect of the closed lower end.

Intestinal Implantation has generally been used to signify the implantation, or union, of the end of one piece of intestine into an opening in the lateral, antimesenteric aspect of another coil – following the excision of a segment of intestine. This process of union imitates the union of the ileum with the colon (cecum).

Entero-enterostomy signifies the junction of the lumen of some part of one intestinal coil with the lumen of some part of another. Strictly speaking, therefore, "entero-enterostomy" is a term of broader significance than those above used, and includes anastomosis, approximation, and implantation. It is a preferable generic expression of the technic in question _ and to secure the shades of differences expressed in the terms "intestinal anastomosis," "approximation," and "implantation," as originally used, it would be better to employ the expressions, entero-enterostomy by end-to-end anastomosis (or approximation), entero-enterostomy by lateral anastomosis (which would not signify that a part of the intestine had been excised unless this fact was covered by such wording as, entero-enterostomy by lateral anastomosis, following partial enterectomy), entero-enterostomy by end-in-side implantation, and the like. While, therefore, entero-enterostomy expresses the junction of lumina of segments of intestine, the method of that junction is best expressed by following the generic term by some specifically qualifying words.

Many of the methods used for variously uniting segments of the intestines to each other are also employed to unite portions of the intestine with different parts of the stomach _ and also with the gall-bladder _ as have been described under such operations as gastro-enterostomy, and cholecysto-enterostomy, by simple suturing, or by the Murphy button, and the like.

Methods of Accomplishing Intestinal Anastomoses or Joinings.—An unusually large number of different technics have been worked out for uniting segments of the intestinal canal _ the vast majority of them being for union of the lumina of the segments following partial excision of some part of the tract _ while some are for short-circuiting methods, independently of partial enterectomy. Surgical literature of the intestinal tract has been embarrassed by the exceptionally large number of methods of entero-enterostomy which have appeared from time to time. These have, undoubtedly, served a useful rôle in the development of this very important branch of Surgery _ but, as matters stand at the present day, the trend is toward a single technic _ that of entero-enterostomy by methods of simple suturing.

For the purpose of covering the field of entero-enterostomy in a more complete manner, some of the methods of joining intestinal segments which have been most generally employed under the different divisions of the subject, will be given _ with the methods of intestinal anastomosis by simple suturing stressed.

The four divisions under which Entero-enterostomies seem to naturally group themselves are the following: _ (1) Union by methods of simple suturing, _ (2) Union accomplished by means of suturing the segments over retained absorbable mechanical devices, _ (3) Union of the intestinal segments by means of retained non-absorbable devices (which are subsequently passed by rectum), _ (4) Union of the intestinal segments through the aid of mechanical means temporarily used during suturing. Under these headings, and in this order, will the chief methods be described.

Note.—In most operations of Entero-enterostomy a previous excision (partial enterectomy) has generally been performed. In the following operations of Entero-enterostomy the joining of the portions of intestine will (to make the operation more complete) be supposed to follow, in the majority of cases, excision of some part of the bowel. Of course, the same operations which are applicable after the excision of a part of the intestine are also applicable after a circular division (circular enterotomy) of the bowel without any excision of a part of the canal.

Indications for Entero-enterostomy, in General.—Injury _ gangrene _ stricture _ tumors _ local tuberculosis _ mesenteric thrombosis and embolism _ some cases of intussusception and of volvulus _ in doubtful viability of the intestine _ in some adhesions _ in some cases of adjacent visceral involvement _ in some cases of artificial anus and fecal fistulæ _ in some chronic inflammatory conditions.

ENTERO-ENTEROSTOMY BY METHODS OF SIMPLE SUTURING

IN GENERAL

Union is here accomplished by the ordinary methods of suturing, unaided by mechanical devices other than the suturing paraphernalia.

For the general principles of intestinal suturing, see Enterorrhaphy, in General, p. 632.

Fine silk or fine chromic catgut may be used throughout. Or, preferably, catgut may be used for the first tier and silk for the second. This applies whether the first tier includes all the coats or only the mucous membrane.

Some surgeons prefer to use only interrupted sutures throughout in intestinal suturing _ upon the ground that in continuous suturing (especially when of silk) the size of the opening becomes more or less fixed and less capable of the distention which, on the other hand, may readily occur in all forms of interrupted sutures.

It is well to bear in mind that sometimes Lembert interrupted sutures which may appear to be near enough in the undisturbed condition of the gut become too far apart when it is distended.

No matter what form of suturing be used for the first tier, the second tier should include only the serous, muscular, and, if possible, part of the submucous coats _ and should bury in the first tier.

Difficulties encountered in placing sutures may be largely overcome by seizing the site to be sutured with delicate forceps and thus causing that part to meet the needle with its proper aspect rendered prominent by eversion, inversion, traction, etc.

When segments of unequal size are to be approximated end to end the only way this can be done by simple suturing is either, (*a*) to partially close the opening of the larger gut down to the size of the smaller, which may be accomplished by taking a V-shaped piece out of the antimesenteric aspect of the larger gut and then suturing together the edges of the V before making the junction, _ or (*b*) by cutting the opening of the smaller gut obliquely (Wehr's method) instead of transversely, at the expense of the free border, and thus increasing its size to match the larger gut. The best end-to-end methods, however, of uniting segments of unequal size are probably either by the Murphy button or the Maunsell method.

END-TO-END ENTERO-ENTEROSTOMY BY SIMPLE SUTURING, AIDED BY TRIPLE-BLADED CLAMPS, FOLLOWING PARTIAL ENTERECTOMY

Description.—Following the excision of the indicated portion of the intestine, the two opened barrels of the bowel are held in symmetric relation with each other, by the middle blade of the clamp between the two limbs of the intestine, and by the outer and inner blades compressing the proximal and distal intestinal limbs against it. These bowel ends are then united by a through-and-through continuous or interrupted tier of fine catgut suturing of the margins of all the coats, followed by a non-penetrating, continuous, or interrupted suturing of the serosa, muscularis, and part of the submucosa with silk.

Preparation – Position – Landmarks – Incision.—As for abdominal section.

Operation.—The steps of the partial enterectomy may be carried out as described under that operation (v. p. 666), using four ordinary clamps, and dividing the intestine between the proximal and distal pairs. If this course be adopted, the ends of the intestine are shifted from their original respective single clamps, and are then carefully caught by and adjusted between the triple blades of a tribladed clamp of the general pattern shown in Figs. 3855 and 3856. Great care is necessary to avoid soiling of the field by drippings from the cut ends of the intestine, even independently of the additional danger of soiling during the shifting of the clamps. Therefore, instead of pursuing this course, it is better to deliver well out of the abdomen the coil of intestine which it is intended to excise and to apply two sets of tribladed clamps, in the manner pictured in Fig. 3857. The two pairs of clamps include the intestine, and may but generally do not include the mesentery. Where they

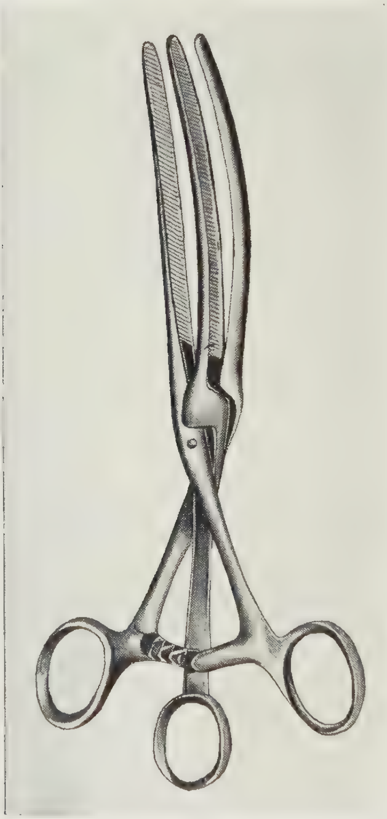


Fig 3855.—Linnartz Three-bladed Intestinal Clamp-forceps.

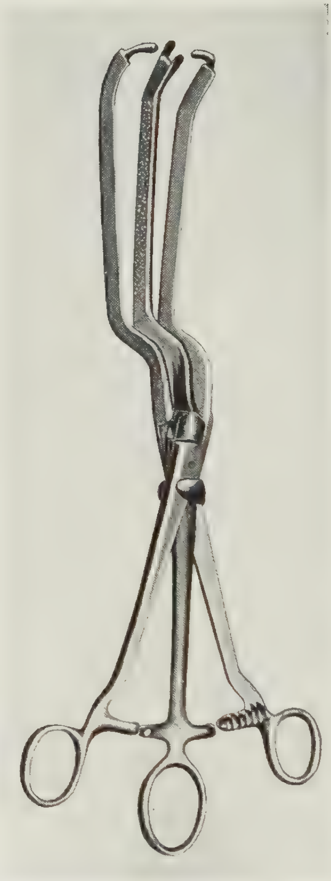


Fig. 3856.—Lynn Thomas' Three-bladed Intestinal Clamps.

do not include the mesentery the V-shaped portion of the mesentery which is to be excised along with the portion of intestine, has its vessels previously ligated with catgut immediately outside of the two lines of division, just as described under Partial Enterectomy. Where the clamps include the mesentery, the mesenteric vessels are controlled during the section, and are subsequently picked up and ligated as they lie free between the leaves of the mesentery, just beyond the clamps. In using the double pairs of tribladed clamps, when all is in readiness, the excision is accomplished by cutting away the intestine, with scissors or knife, between the two sets of clamps, and along the lower aspect of the upper set _ as seen in the picture just quoted.

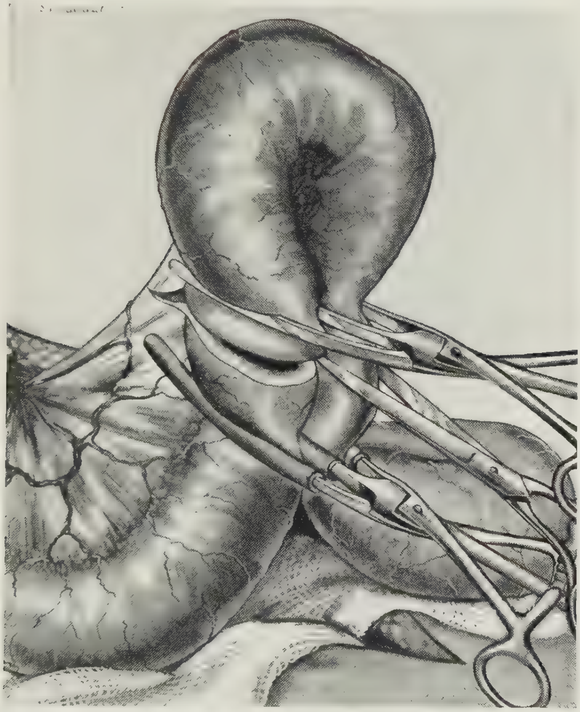


Fig. 3857.—End-to-end Entero-enterostomy by Simple Suturing, Aided by Triple-bladed Clamp, Following Partial Enterectomy _ I: _ The knuckle, or loop of intestine is drawn out of the abdomen and two triple-bladed clamps applied, with about 2.5 cm. (1 inch) between them, in the clear _ the lower set being those to be permanently retained during the completion of the anastomosis _ the upper set controlling the ends of the portion of intestine to be excised. Scissors are in the act of dividing the intestines nearer the upper clamps.

Calculation is made to leave enough of the two barrels of intestine projecting beyond the clamps for manipulation in suturing. When the mesentery has not been included in the clamps, but its vessels previously ligated by being underrun with catgut ligatures, after severing the coil of intestine, the incision is then extended on through the mesentery, so as to fall just within the limbs of the V-shaped figure formed by the ligation of the mesenteric vessels.

The excised portion of the bowel and corresponding portion of the mesentery are now removed _ the intestinal openings wiped with gauze _ and soiled packing in the neighborhood carefully removed and renewed _ preparatorily to the steps of the anastomosis. The first tier of silk suturing is now applied – the tier which is the lower, or more posterior of the two posterior rows of suturing, and, at the same time, a little less accessible than the two rows upon the anterior, or upper aspect. This tier begins by passing through the adjacent serous coverings of the mesentery (not through the entire mesentery), at the apex of the incision, and is knotted, bringing the serous surfaces of this aspect of the mesentery into contact – the free end of the suture then serving as a tractor (Fig. 3858). Traction in the opposite direction is maintained by gentle tension between this silk tractor (or the mesentery may be here seized by a pair of tenaculum-forceps) and the triple clamp With the parts thus gently tensed, this stitch is continued through the opposite serous coats of the mesentery, until the antimesenteric aspects of the intestinal ends are reached – when the stitch begins to pass through serosa and muscularis and part of the submucosa of the intestinal ends, on each side, and at sufficient distance from the free margins of the intestines to leave room for the marginal stitch – and runs in this way until the antimesenteric aspects of the two open barrel ends are reached, when the last stitch may be run through a second time, to prevent slipping of the suture – after which this suture is temporarily laid aside still threaded.

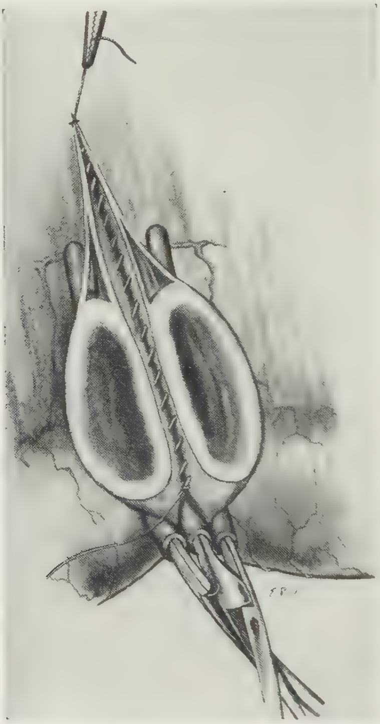


Fig. 3858.—The Same – II; – The posterior tier of seromuscular, continuous suturing – of both the barrels of the intestine and of the contiguous surfaces of the mesentery. The ends of the stitch are left long, one serving as a temporary tractor.

The second tier of posterior suturing is a through-and-through fine chromic catgut marginal stitch of all the coats. It passes from the mesenteric, toward the antimesenteric aspect, through the margins of the two borders of the intestine which are in contact. The most important step of this stitch is where it not only brings the separated leaves of mesentery of each end of the intestine closely around their own piece of intestine, but also the contiguous pieces of mesentery into contact with each other (Fig. 3859). The Lee mesenteric stitch is sometimes put in separately.

The first tier of the anterior suturing is, similarly, a through-and-through fine chromic catgut stitch of all the coats, and is the continuation of the second, or posterior marginal tier. It passes backward, from the antimesenteric, toward the mesenteric aspect, through the margins of the two aspects of the intestine which are farthest away from each other, bringing them into contact _ as shown in Fig. 3860.

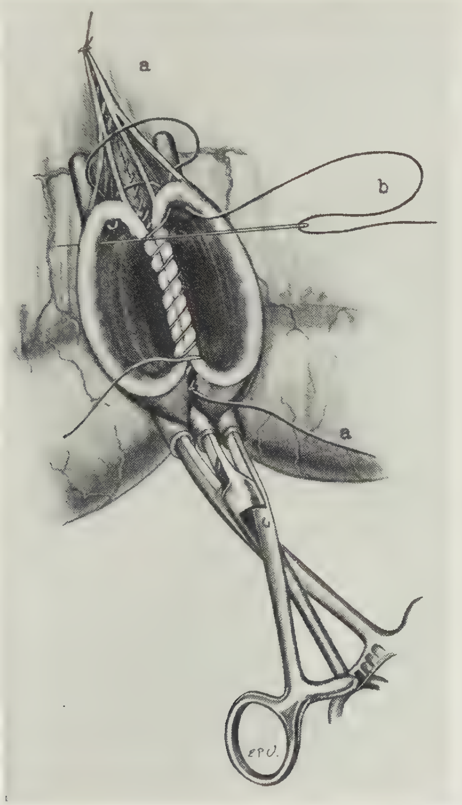


Fig. 3859.—The Same _ III; _ The margins of cut mesentery and the intestinal ends are put under gentle traction, paralleling their structures. The first posterior tier of silk suturing has been applied, uniting the opposite leaves of the mesentery, and passing through the serosa, muscularis, and part of the submucosa of the adjacent walls of the ends of the intestine, about 5 mm. ($\frac{3}{16}$ inch) from the cut edges. In this picture the beginning of the second posterior tier of suturing is shown loosely placed to show the manner in which it approximates the leaves of the mesentery to the barrels of their own pieces of bowel, as well as to each other. The principle of the Lee mesenteric stitch is here shown as part of a continuous suture.

The second tier of the anterior suturing corresponds with the first tier of the posterior suturing, of which it is the continuation. The first silk suture, temporarily laid aside, is now picked up and is continued backward, from the antimesenteric toward the mesenteric aspect _ passing through the serous, muscular, and part of the submucous coats (Fig. 3861). When it reaches the mesenteric aspect of the two pieces of bowel, a loop is drawn through on one side and tied with the needled end of the suture on the other _ after which the loop is cut off _ and the free end of the suture is carried toward the root of the mesentery, in overhand fashion, uniting the free margins of the cut mesentery, as seen in the illustration.

Finally, the handled portions of the intestine, in the immediate vicinity of the operation, are wiped with gauze wrung out in saline solution _ the gauze packings removed _ and the intestines dropped back into the abdominal cavity.

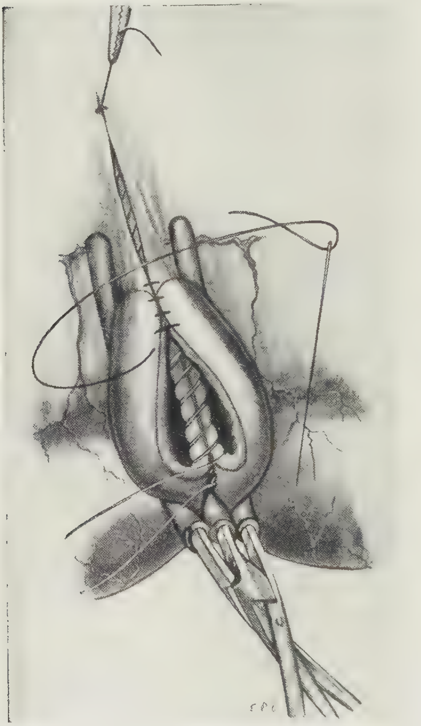


Fig. 3860.—The Same _ IV; _ The first tier of anterior marginal suturing _ a continuous, through-and-through stitch, and a continuation of the posterior marginal suture _ is being brought forward through the anterior lips of the intestinal openings _ to be tied to the long end of the stitch, left free at the beginning. This last inner knot will be tied on the outside _ and then be tucked into the lumen of the bowel with the blunt end of a probe.

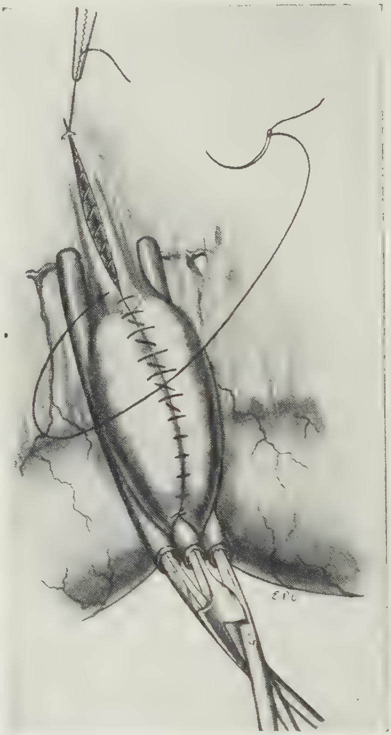


Fig. 3861.—The Same _ V; _ The second tier of the anterior suturing is a continuation of the first tier of the posterior silk suturing _ passing through the serosa, muscularis, and part of the submucosa of the intestinal walls adjacent to the margins _ and, on uniting these, and after being knotted, is continued as a marginal suture of the free edges of the mesentery, which is seen in the act of being brought together.

The question of peritoneal drainage will be determined by the circumstances of the particular case. In average cases it is omitted. The abdomen is closed as usual.

Comments.—It is really not necessary that the first tier of posterior suturing should include the opposite serous surfaces of the mesentery _ but may simply begin at the leaves of the mesentery where they separate to enclose the intestine. In this case the final, or seromuscular tier of anterior suturing, after being knotted when its intestinal portion is completed, at the mesenteric aspect, is continued as an overhand suture of the free margins of the mesentery.

END-TO-END ENTERO-ENTEROSTOMY BY SIMPLE SUTURING, AIDED BY DOUBLE CLAMPS, FOLLOWING CIRCULAR ENTEROTOMY OR PARTIAL ENTERECTOMY

Description.—The portion of intestine to be excised is "milked" of its contents, proximally and distally, and then compressed with a double-bladed intestinal clamp just to the outer side of each of the sites of division.

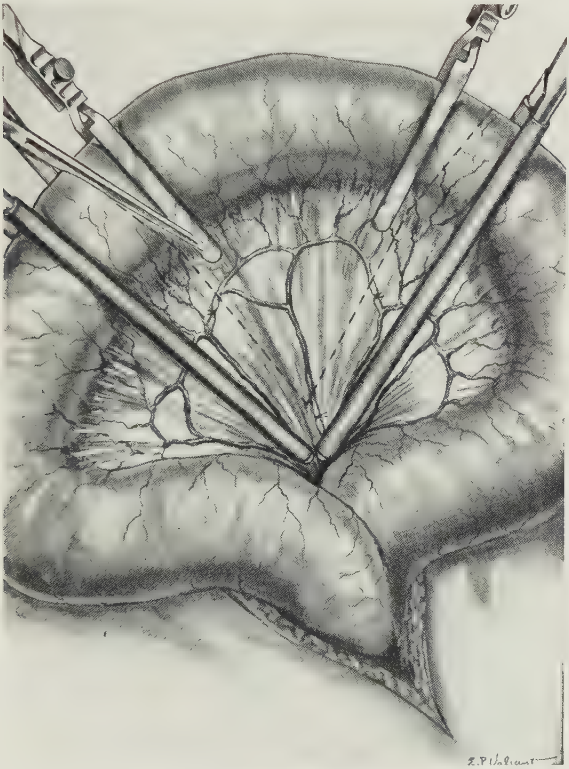


Fig. 3862.—End-to-end Entero-enterostomy by Simple Suturing, Aided by Double Clamps—Following Circular Enterotomy or Partial Enterectomy—I;—Two intestinal clamps are applied just beyond the sites of division, crossing the intestine with slight obliquity, to preserve better vascularization of the antimesenteric borders. Intestinal clips are placed just within the lines of division. The mesenteric vessels are ligated just outside of the dotted lines.

To the inner side of these clamps two intestinal clips are applied. The part of the intestine is then excised between them, with the corresponding portion of mesentery lying within the area of previously ligated mesenteric vessels. The intestinal ends and mesenteric borders are then united by sutures in the way to be described.

Operation.—Having delivered the coil of intestine and pressed away its contents, two double-bladed intestinal clamps are applied just beyond the regions of division—and two intestinal clips are applied within these—to control leakage as far as possible—their application being as shown in Fig.

3862. The excision of intestine and mesentery is then made along the dotted lines indicated in the above picture – the intestine being cut with slight obliquity, at the expense of its antimesenteric border, to insure safer blood-supply to that border. The parts are then thoroughly cleansed, ready for iuturing. Manipulated by the clamps, the intestinal ends are now brought snto convenient relationship for suturing.

The first step in the anastomosis is provision for the approximation, by suture, of the leaves of the mesentery to the individual ends of the cut intestine, and to each other. This may be accomplished in one of several ways. One of the best methods is Lee's (Figs. 3859 and 3865, **a**), in which both leaves of the mesentery of each intestinal barrel are brought into contact with their own barrel, and with each other, by a mattress type of suture (fine chromic catgut) which penetrates all four mesenteric leaves and both intestinal walls, and is tied within the lumen of one of the ends of the intestine. It may also be accomplished by ordinary interrupted sutures, as seen in Fig. 3863.

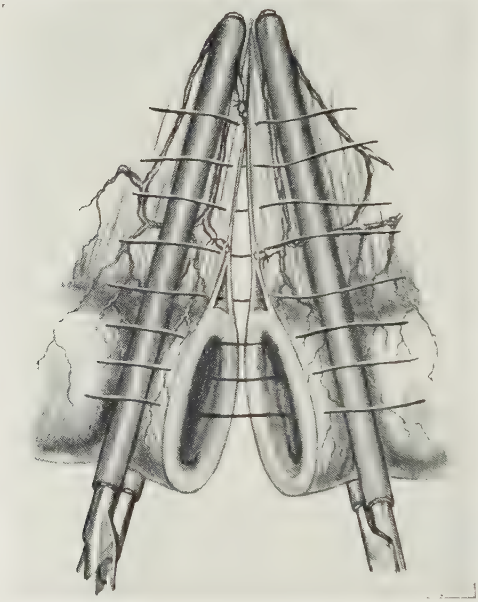


Fig. 3863.—The Same – II; – Following excision the opposite ends and mesenteric borders are approximated by the clamps and held in convenient relationship for through-and-through marginal suturing – here shown as interrupted – and with the handles of the clamps downward, while suturing the aspect of the parts facing the Surgeon. The leaves of the mesentery are being brought together by Shoemaker's stitch – two generally being used.

The through-and-through marginal suturing (interrupted or continuous) of fine chromic catgut is applied to the anterior aspect of the free intestinal borders – beginning at the mesenteric and working toward the antimesenteric aspect – while the double clamps, manipulated by an Assistant, hold the ends in proper relationship – the Surgeon picking up the site of each needle puncture with forceps, steadying it for the penetration of the needle. The mesenteric margins are sometimes sutured while placing this tier.

The through-and-through marginal suture is continued through the free intestinal borders of the posterior aspect of the intestinal ends in exactly the same manner as through the anterior borders _ to accomplish which, conveniently, the double clamps are now thrown upward _ thereby reversing the presentation of the intestinal ends.

Dropping the clamps back into the original position, on completing the suturing of the posterior margins, the anterior tier of silk suturing through the serosa, muscularis, and part of the submucosa is placed. While placing this anterior tier of seromuscular sutures, it is convenient to whip together the free margins of the mesentery, if not already done _ as shown.

Once more the clamps are thrown upward, and the ends of the intestine reversed _ while carrying the silk suture through serosa, muscularis, and part of the submucosa along the posterior aspect of the intestinal ends (Fig. 3864).

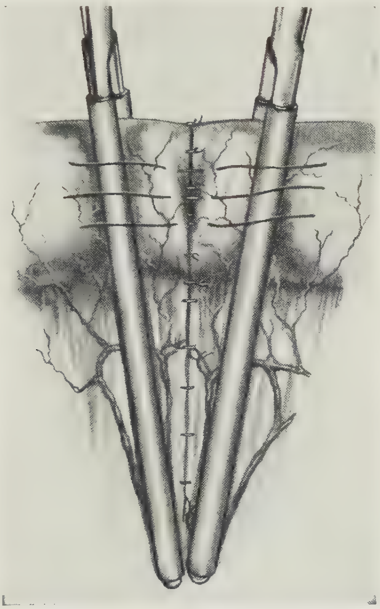


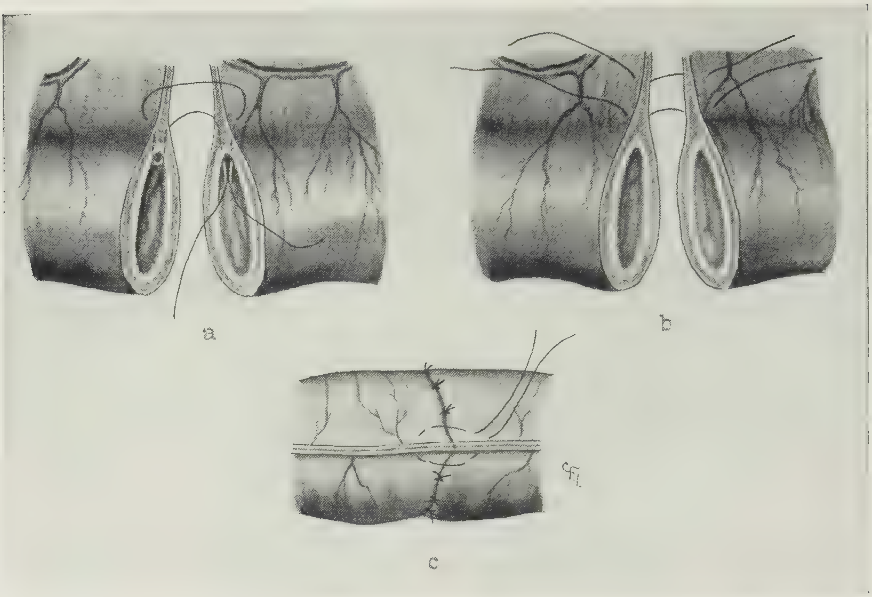
Fig. 3864.—The Same _ III; _ The handles of the clamps are now thrown upward, so as to reverse the presentation of the intestinal ends, while the posterior aspect of the suturing is carried out _ the marginal and outlying seromuscular tiers

Owing to the slight obliquity of the intestinal divisions, the restored intestine will have a slight angularity at the site of union, which is no detriment, comparable with the better blood-supply thereby provided.

The site of anastomosis is then cleansed _ the packing removed _ and the abdomen closed.

Comments.—Both in ligating the mesenteric arteries, and especially in placing the stitch (of whatever kind it may be) which holds the leaves of the mesentery in relation with the ends of the intestines and with each other, it is of especial practical importance to see that no vessel is obliterated which supplies any portion of the margin of the cut intestine.

Several forms of suture have been devised to strengthen the weakest part of the entire circumference _ where the leaves of the mesentery separate to surround the intestine. The three most usually employed methods are those of Lee, of Shoemaker, and of Mitchell and Heamner (Figs. 3865–3867).



Figs. 3865–3867.—Suturing Methods of Binding the Leaves of the Mesentery to the Individual Intestinal Ends and to Each Other: – **a**, Lee's method; – **b**, Shoemaker's method; – **c**, Mitchell and Hunner's method.

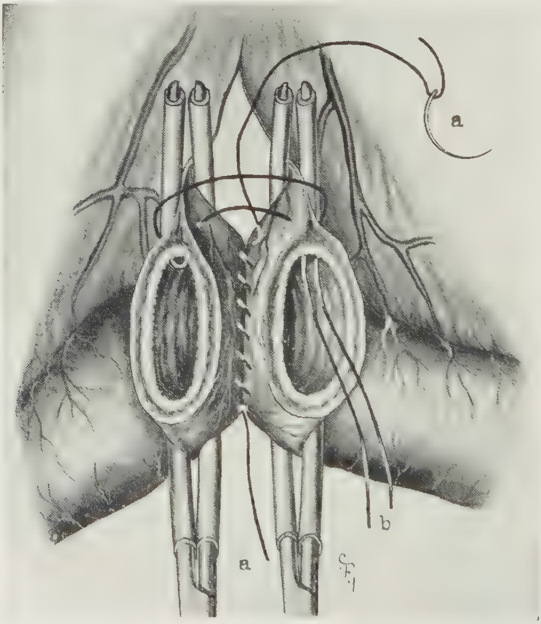


Fig. 3868.—End-to-end Entero-enterostomy by Simple Suturing, Aided by Double Clamps, and with Lee's Method of Approximating the Leaves of the Mesentery – I: – **a, a,** The posterior seromuscular, continuous Lembert suture; – **b,** Lee's mesenteric suture, approximating the leaves of the mesentery of each intestinal barrel to themselves, and to the leaves of the opposite barrel.

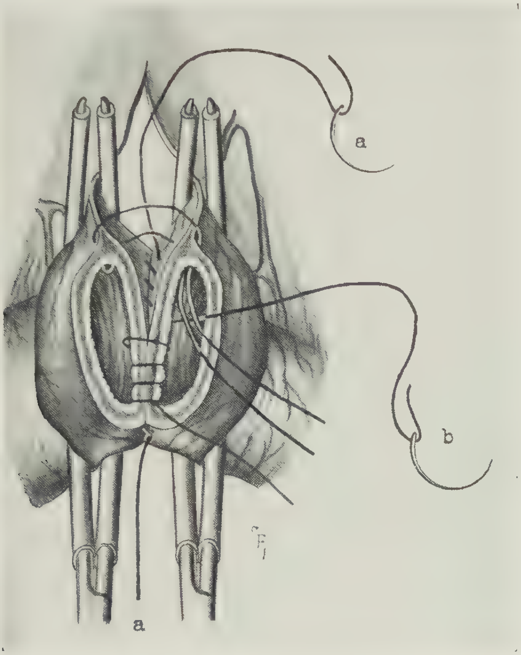


Fig 3869.—The Same; _ The posterior marginal catgut sutures are placed while the parts are held in the same position: _ a, a, Posterior seromuscular stitch; _ b, posterior marginal stitch.

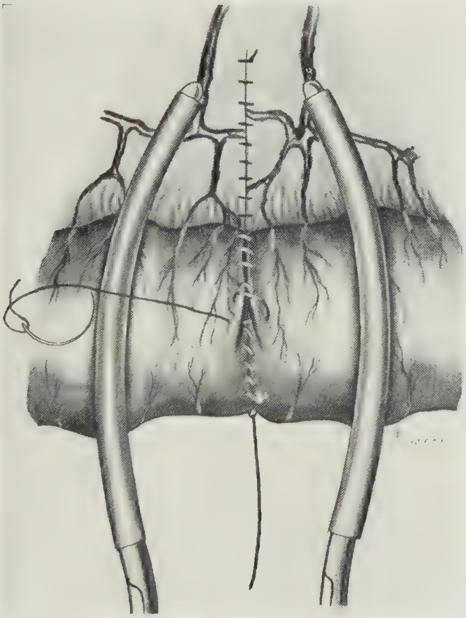


Fig. 3870.—The Same _ III; _ The clamps are now rolled toward each other, through a quarter circle _ causing the anterior lateral aspect of the bowel ends to face the Surgeon _ and, while so held, first the marginal tier of sutures is completed, and then the seromuscular tier. The mesenteric margins are whipped together.

An alternative method of handling the clamps and applying the sutures in this method of anastomosis _ which is more convenient to some Surgeons _ is the following: _ Instead of holding the two pairs of clamps in such a manner as to present the anterior lateral aspect of the two ends of intestine which are being anastomosed, these ends are so held that their ends face the Surgeon's as the two ends of a double-barreled shotgun facing him (Fig. 3868). The posterior row of silk seromuscular sutures are placed while the intestinal ends are thus held _ and as shown in the picture quoted. And while still in the same position, the posterior row of the chromic catgut marginal sutures is placed (Fig. 3869). Then, to reach the anterior aspect of the intestinal ends, the two clamps are rolled inward, toward each other, through a quarter circle (until the sides of the blades, and not their borders, are facing the Surgeon). While in this position, first the catgut marginal suture is continued through the anterior borders (Fig. 3870), after which the silk seromuscular suture is carried through the tissues of the anterior paramarginal tissues _ and through the edges of the split mesentery.

END-TO-END ENTERO-ENTEROSTOMY BY SIMPLE SUTURING WITHOUT THE AID OF CLAMPS, FOLLOWING CIRCULAR ENTEROTOMY OR PARTIAL ENTERECTOMY

Description.—No marginal clamps are here employed for holding the severed ends of the intestine in relationship during the anastomosis _ although intestinal clips are employed at a reasonable distance on each side to control intestinal flow. The approximated intestinal ends are conveniently held over the radial aspect of the Surgeon's second finger, between his thumb and first finger, during the placing of the mesenteric stitch and the marginal sutures _ and between the fingers of both hands of an Assistant, during the passage of the seromuscular sutures.

Operation.—Having delivered the loop of intestine and packed off the field _ "milked" away its contents to both sides of a middle point and applied controlling intestinal clips, to prevent the flow of intestinal fluids _ the partial excision of the intestine, with the corresponding portion of the mesentery, is accomplished in the usual manner _ after which all is in readiness for the anastomosis. The two ends of the intestine are now brought into convenient apposition for suturing, and are digitally held in apposition during the placing of the first tier of sutures. The first row of continuous suturing passes through all the coats of the proximal and distal segments of the intestine, and consists of a continuous catgut suture carried upon a straight needle held in the fingers. The Surgeon holds the approximated borders of the two coils of intestine over the radial aspect of his left second finger, approximating the opposite borders with the left first finger and thumb. (See Fig. 3871.) Four thicknesses of bowel are thus brought together, two from the proximal and two from the distal end of the divided intestine. The adjacent aspects of the apposed edges should be first sutured (Fig. 3872, A). The needle should first enter at the antimesenteric borders, the first stitch being so placed as to leave the free end of the suture, after knotting, on the outside, which is done by beginning the stitch from without and then passing the needle back into the lumen after tying the first knot. After the needle has passed back into the lumen it should always, in going toward the mesenteric attachment, travel from within outward through the wall of the intestine on the right (nearer the operator) _ then from without inward through the wall of the intestine on the left (further from the operator) _ and so on, descending toward the mesenteric aspect. The last stitch before beginning the return includes, besides the two thicknesses of the bowel, also the two laminæ of mesentery which are adjacent (one from the proximal and one from the distal portion of bowel). And the first stitch, after beginning the return, includes, besides the two thicknesses of bowel, also the two laminæ of mesentery (one from the proximal and one from the distal portion of bowel) which are furthest from each other at the taking of the stitch, but which will be brought into contact by the stitch (Fig. 3873, B). The suturing is then continued back to the antimesenteric aspect in an overhand stitch as before _ passing, now, from without inward through the wall of the intestine nearer the operator, and from within outward through the wall of the intestine further from the operator. When the last stitch is reached, its free end on the outer side is knotted to the free end left on the outer side at the start (Fig. 3874, C).

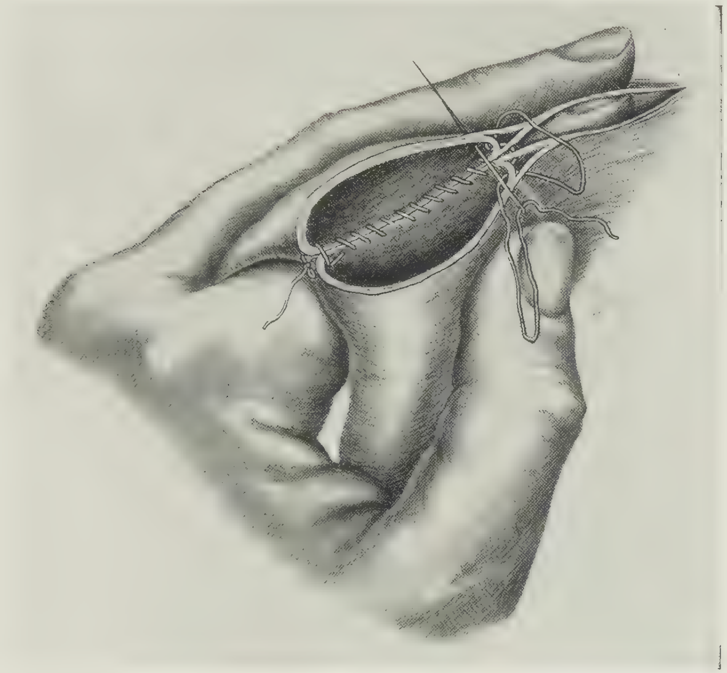


Fig. 3871.—Entero-enterostomy by Simple Suturing Without Clamps _ I; _ A method of holding the intestine and introducing the first tier of simple continuous overhand suturing of all coats. Note: The intestinal ends are wrongly represented supported by the first finger _ but should be held over the second finger, with the thumb and first finger approximating their open ends.

During the return row of suturing care is taken that the stitches do not penetrate the coats already whipped together by the first row _ which is easily avoided, as the edges are all in plain view as each needle puncture is made.

The second row of suturing consists of interrupted Lembert sutures passing through the serous and muscular and part of the submucous coats. The sutures are silk, carried upon a straight needle held in the fingers. The barrel of intestine is now held out straight by an Assistant, who grasps it about 10 cm. (4 inches) on either side of the suture line _ while the operator picks up a transverse fold of the bowel wall near the original suture line by means of forceps held in his left hand _ and a similar fold just beyond the suture line _ passing the needle through both folds in the ordinary Lembert fashion (Fig. 3875). One-half of the circumference of the bowel is sutured

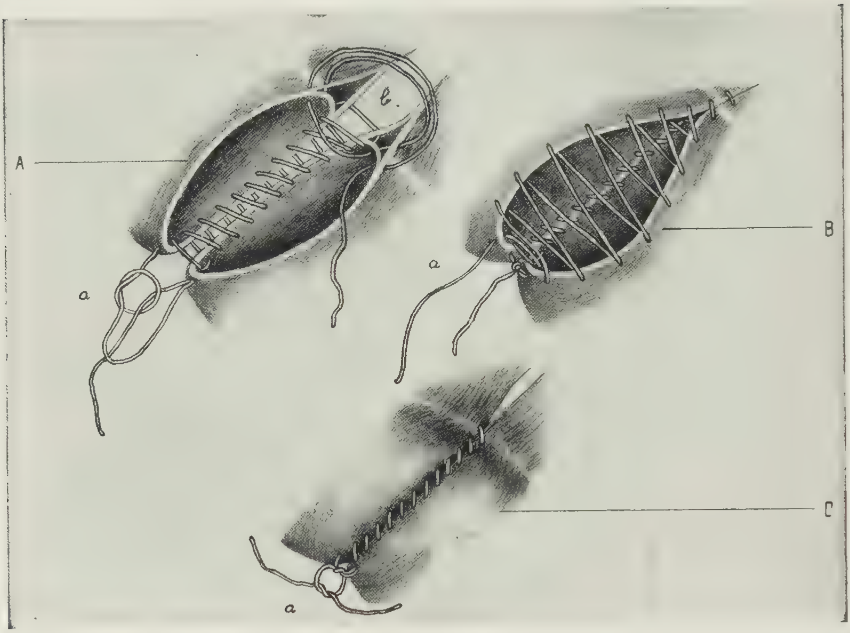


Fig. 3872–3874.—The Same _ II–IV: _ A, Manner of knotting and beginning suture at **a** _ traversing posterior edges of intestines _ and including laminæ of mesentery at **b**, whence the suture starts to return; **B**, manner of traversing anterior edges of intestines _ and ending the suture at **a**, preparatory to knotting; **C**, manner of tying final knot of first tier of sutures at **a**, and appearance of suture line and approximated leaves of mesentery.

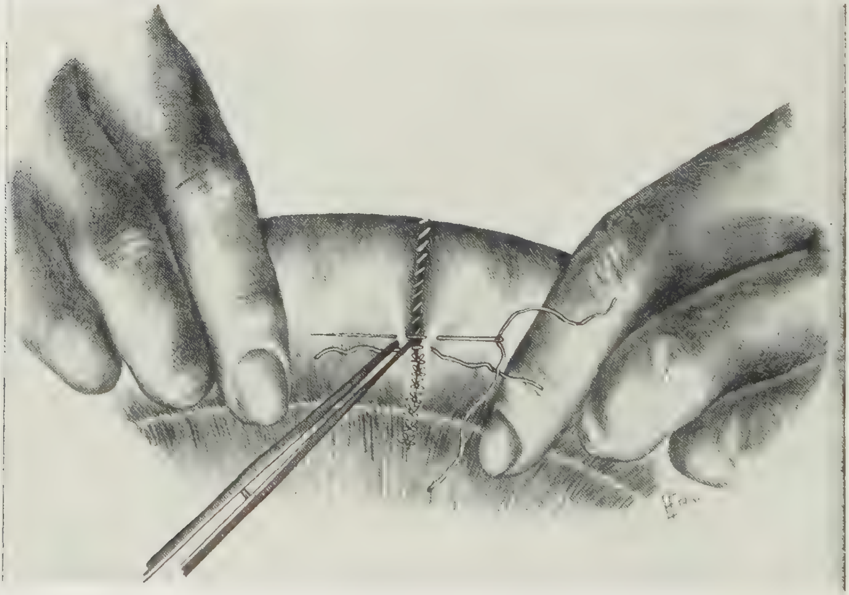
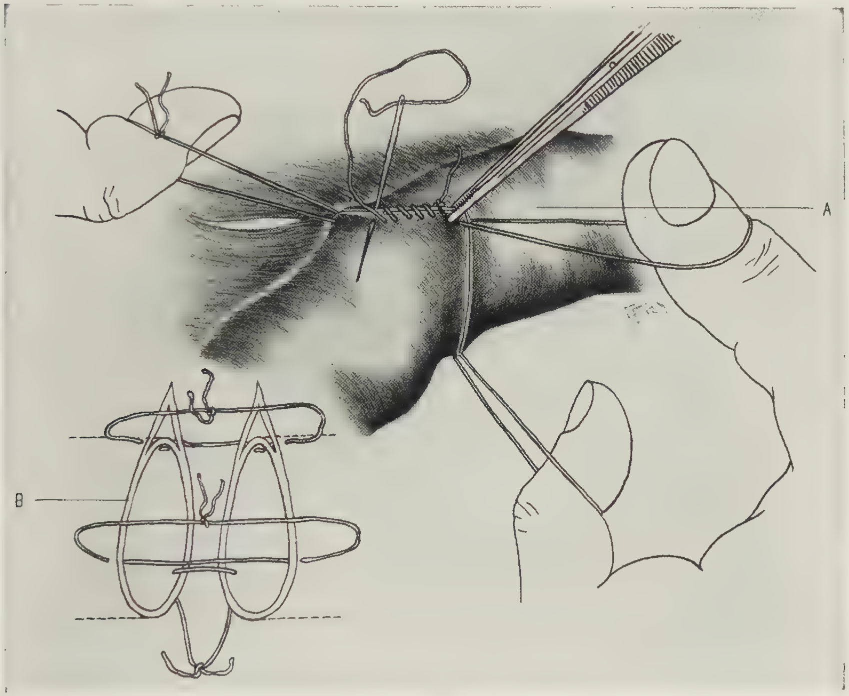


Fig. 3875.—The Same _ V; _ A method of holding the intestine and introducing the second tier of interrupted Lembert sutures, which is seen burying in the first tier of continuous overhand suturing.

from one side, after which the intestine is turned upward and the other half sutured from the opposite side. The sutures are inserted in the usual manner of the Lembert method – the forceps picking up the tissue in transverse folds and thus drawing it away from the opposite wall, thereby making the passage of the suture easier, and the penetration of the opposite wall impossible. Especial care is necessary as the diverging laminæ of the mesentery are encountered, in order that each lamina may be closely approximated to the barrel of its own segment of intestine and to the opposite lamina on the same side of the intestine. The Lembert sutures should, therefore, be continued on down to the very junction of the mesentery with the intestine and slightly beyond.



Figs. 3876 and 3877.—Entero-enterostomy by Simple Continuous Overhand Suturing of All Coats, Followed by Interrupted Lembert Sutures of Outer Coats: – A, Another method of holding the intestines and introducing the first tier of simple continuous suturing of all coats; B, diagram showing manner of introducing the three preliminary traction sutures.

Comment.—Instead of holding the intestines as above described during the placing of the first tier of sutures, other methods of holding them in apposition may be employed. Three interrupted sutures may be placed and knotted in loops as temporary traction sutures – each including all the coats of the two adjacent walls of the proximal and distal segments of intestine – one placed at the mesenteric aspect – and the other two dividing the circumference of the severed ends into three equal parts. An Assistant now draws these three loops in different directions (which a single Assistant can do by hooking them over his fingers, if the loops are not too long) – whereby two objects are accomplished: – one-third of the margins of each bowel is brought into contact, – and the margins of the other two-thirds are held out of the way (and thus the penetration of their wall by the needle rendered impossible). While held in this manner the adjacent margins of each third are whipped together by a continuous overhand suture—after which the temporary traction-loops are cut and withdrawn (or may be tied and cut short, as permanent interrupted sutures reinforcing the continuous ones). The second tier of interrupted Lembert sutures is applied as just described. Or the traction sutures may be retained until the Lemberts are placed, to draw the edges parallel.

This technic is shown in Figs. 3876 and 3877.

END-TO-END ENTERO-ENTEROSTOMY BY SIMPLE SUTURING BETWEEN INTESTINAL LOOPS OF UNEQUAL SIZE

The joining of pieces of intestine, end to end, which present disparity of diameter, is difficult of satisfactory accomplishment by the ordinary methods just described. The following are the measures usually adopted:—

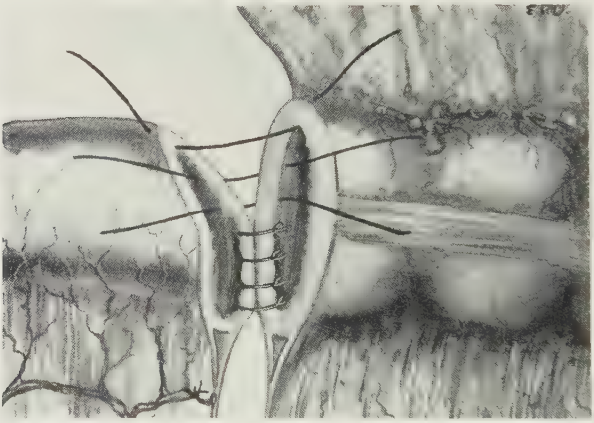


Fig. 3878.—End-to-end Anastomosis of Intestinal Segments of Unequal Diameter by Enlarging the Smaller Diameter, by Means of a V-shaped Excision, to the Size of the Larger Diameter (Jeannel).

(*a*) End-to-end junction of unequal diameters by the Maunsell method. This is probably the best technic—and will be described and pictured at pp. 715–723.

(*b*) End-to-end junction of unequal diameters by enlarging the smaller diameter, by means of a V-shaped excision, to the size of the larger diameter (Jeannel). This is probably the second best method. In Fig. 3878 are shown two segments of unequal diameter being thus joined. After proper calculation, a V-shaped piece, slightly curving as it comes into the transverse section, is removed from the smaller piece of intestine. The opposite margins of the two pieces of bowel are then first united by through-and-through fine chromic catgut sutures. They are shown placed and tightened, opposite the mesenteric aspect of the two pieces of intestine—and loosely placed, ready for tightening, as they are continued upward toward the antimesenteric aspect of the segments. When this first tier of suturing has been tightened throughout, a second tier of silk Lembert sutures is placed in the usual manner—penetrating the serosa, muscularis, and part of the submucosa.

(*c*) End-to-end junction of unequal diameters by decreasing the larger diameter, by means of a V-shaped excision and suturing, to the size of the smaller diameter. Here, the V-shaped excision is made from the antimesenteric aspect of the larger piece of intestine _ after which the sides of the V are first united by through-and-through fine chromic catgut, followed by a second tier of silk sutures of the serosa, muscularis, and part of the submucosa. This converts the larger intestinal end to the size of the smaller intestinal end _ after which they are anastomosed in the usual manner _ first, by marginal through-and-through sutures of fine chromic catgut _ followed by a second tier of silk Lemberts, piercing the serosa, muscularis, and part of the submucosa. In Fig. 3879 the V-shaped excision has been made and closed _ and the intestinal ends are in the act of being anastomosed. The weak part of this technic is where the axial and the transverse lines of suturing cross.

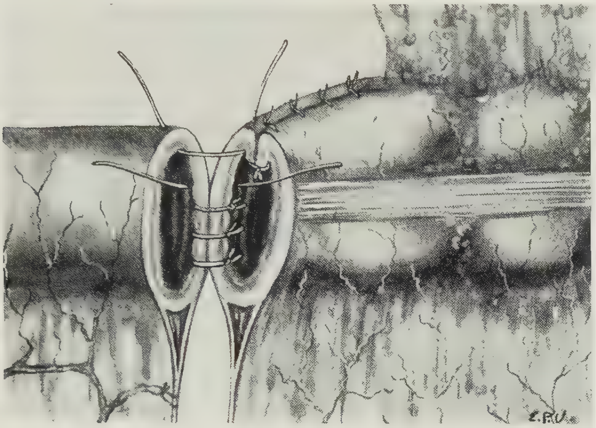


Fig. 3879.—End-to-end Anastomosis of Intestinal Segments of Unequal Diameter by Decreasing the Larger Diameter, by Means of a V-shaped Excision and Suturing, to the Size of the Smaller Diameter.

LATERAL ENTERO-ENTEROSTOMY BY SIMPLE SUTURING, AIDED BY DOUBLE CLAMPS, WITHOUT PRECEDING PARTIAL ENTERECTOMY

Description.—Lateral entero-anastomosis, without excision of any portion of the intestinal tract, is often called for as a routine procedure _ as, for instance, lateral jejunojejunostomy, as an associated step in gastroenterostomy _ and in some conditions where it is indicated to short-circuit the intestinal canal in an inoperable condition, such as malignancy. Incision is made in the antimesenteric aspect of the two pieces of bowel and union occurs between the margins and the peritoneal surfaces brought into contact.

Lateral anastomosis may be carried out in any portion of the small or large intestine where the parts to be anastomosed can be brought into convenient relationship with each other, without distortion and tension. As the axial openings are made in the midantimesenteric part of the two intestinal loops, the incisions only pass through vessels of minimum size, and, therefore, exercise no practical effect upon the blood-supply. The technic is applicable to two loops of small intestine, two loops of large intestine, if approximable, or to a loop of small intestine with a loop of large intestine.

This is, from the mechanical standpoint of accomplishing the union of portions of the intestinal canal, considered the safest against leakage _ but is, of course, not applicable where it is necessary to excise a part of the bowel. The method whereby the lateral method of anastomosis may be applied in cases where a partial enterectomy has been performed, will be described in the operation next following.

Operation.—Owing to the nature of the manipulative procedure, a rather free extent of delivery of the two loops of intestine to be anastomosed is necessary _ after which the intestinal coils are "milked" free of contents, and the operative field is well packed off with gauze pads. Having decided upon the immediate site of incision in each piece of intestine, a generous loop of intestine is drawn between the blades of an intestinal clamp of medium curvature _ and a second loop between the blades of a second pair of forceps _ the antimesenteric aspect of each loop forming the axial center of each clamped portion _ and these two axial centers lying in convenient position for anastomosis. It is well to pack a strip of folded gauze between the clamps to catch any possible escape of intestinal contents, in addition to the packing of the field. The two folds of intestine are then brought into their final relationship and henceforth steadily held in that position, by means of the clamps, until the suturing has been completed.

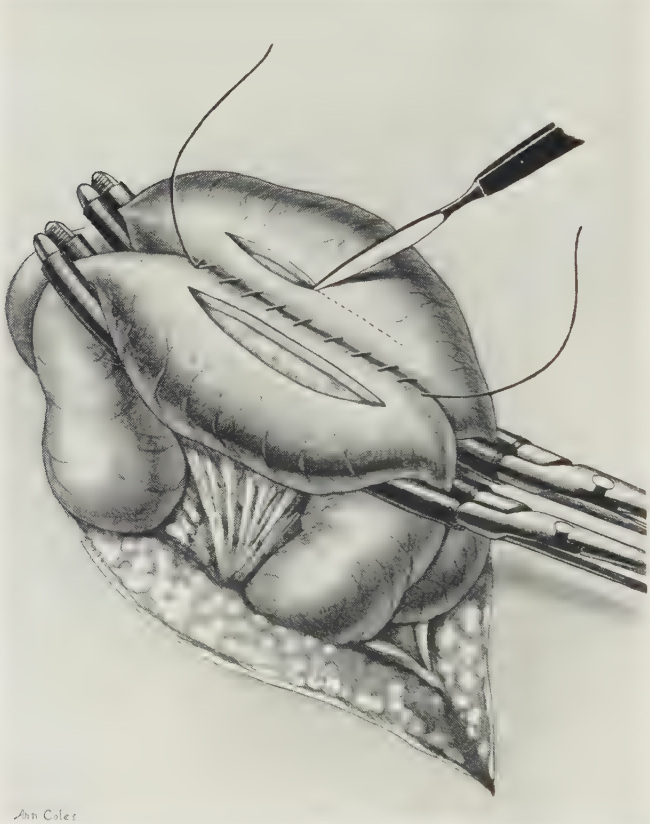


Fig. 3880.—Lateral Entero-enterostomy by Simple Suturing, Aided by Single Clamps _ Without Preceding Partial Enterectomy _ I; _ Each loop of intestine has been correspondingly grasped by a single clamp, and brought into convenient relationship for lateral entero-anastomosis along their antimesenteric aspect. The posterior or inner tier of silk seromuscular suturing has been placed. The serosa and muscularis have been incised down to the mucosa in one coil _ and are being incised in the opposite coil

The posterior or inner tier of silk Lembert suturing passes through serosa, muscularis, and part of the submucosa _ beginning with a knot and ending with a knot, and extending from 6.3 to 7.7 cm. ($2\frac{1}{2}$–3 inches) in length. The free end of beginning, left long, is clamped with forceps, and the free, needled end, left threaded, after knotting (Fig. 3880). To protect the two ends of the entero-anastomotic openings to be made by the incisions Makins carries two short seromuscular sutures transversely across, directly opposite the ends of the sites where the axial incisions will be made, and at some little distance from them, so that, when tied, at the end of the operation, they will outlie the sutured ends, and will protect these sites. These reinforcing sutures, to be tied upon the completion of the operation, are shown in the illustration last quoted. The axial incisions are planned to lie in the middle of the antimesenteric aspects of the two pieces of bowel _ and the posterior tier of seromuscular sutures to lie about 6 mm. ($\frac{1}{4}$ inch) posterior to this site of future incision. As the posterior line of suturing begins and ends, it curves forward slightly, so that the ends will lie directly opposite the tips of the future incision _ and be correspondingly met by the ends of the anterior tier of sutures, to be applied later.

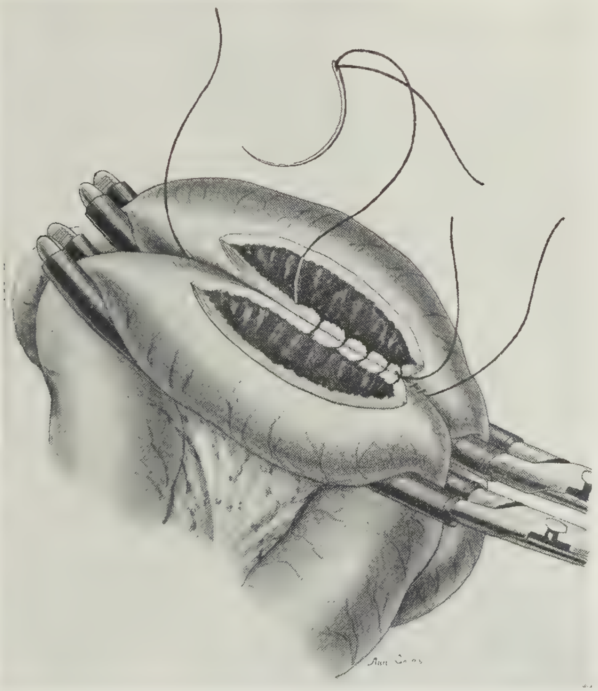


Fig. 3881.—The Same _ II; _ The posterior tier of chromic catgut marginal suturing.

An incision is now carefully made in the midantimesenteric aspect of each piece of clamped bowel _ extending for about four-fifths of the length of the seromuscular suturing which will surround it. The incision passes at first carefully through only the serosa and muscularis _ so that any bleeding vessels encountered may be clamped and tied with fine catgut. The mucosa is then incised, exposing the lumina of the two loops. All escaping fluid from the intestine is caught upon gauze. There is a tendency for the mucosa to bulge into the wound, and, if this occurs, a strip of the redundant mucosa is steadied by forceps and excised by scissors, from each margin of each wound – which will enable the subsequent steps to be more neatly carried out, and prevent any partial blocking of the anastomotic openings with herniating mucosa.

The posterior tier of fine chromic catgut suturing is now carried through all the coats of the free margins of the contiguous cut lips of the openings – knotted at the end of beginning, with the end left free – and again knotted at the opposite end, with that free end left threaded (Fig. 3881).

The anterior tier of marginal suturing is simply a continuation of the posterior tier – the threaded chromic catgut suture being carried through the free lips of all the coats along the anterior boundary of the opening (Fig. 3882).

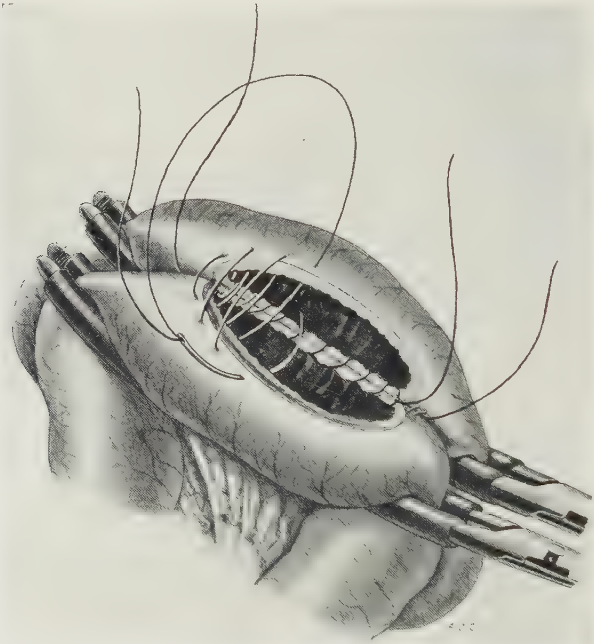


Fig. 3882.—The Same – III; – The anterior tier of chromic catgut marginal suturing – a continuation of the posteri or tier of the same suturing

The anterior tier of silk Lembert suturing passing through the serosa, muscularis, and part of the submucosa, about 6 mm. ($\frac{1}{4}$ inch) outside of the anterior boundary of the anastomotic opening is, similarly, a continuation of the first placed posterior tier of seromuscular suturing. It closes in, finally, the site of anastomosis by completing the outlying tier of reinforcing sutures (Fig. 3883).

Last of all, the two terminal, transversely placed, strengthening sutures are tied.

The site of operation is drained, or not, as indicated – and the abdomen closed.

Comments.—Care should be taken that the loops of intestine are not twisted out of their natural relations in accomplishing the anastomosis.

The terminal reinforcement of the anastomosis site by the two sutures mentioned is sometimes extended to several sutures, covering as much as 2.5 cm. (1 inch) beyond each end _ with or without frictioning the surfaces which are to be sutured together as two end bulwarks, to increase union.

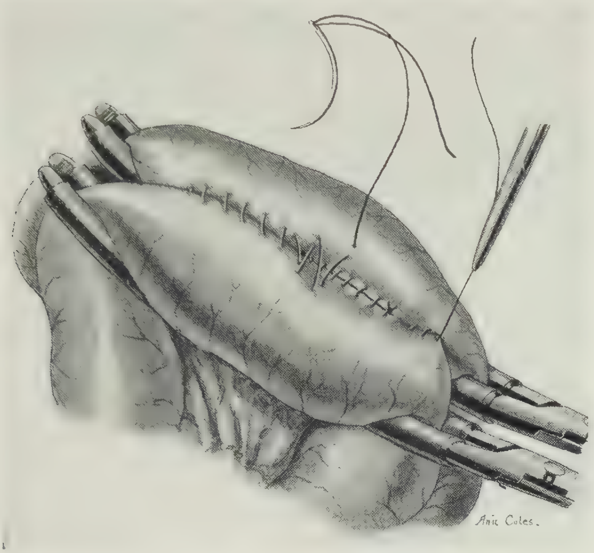


Fig. 3883.—The Same _ IV; _ The anterior or outer tier of silk seromuscular suturing _ in the act of being completed.

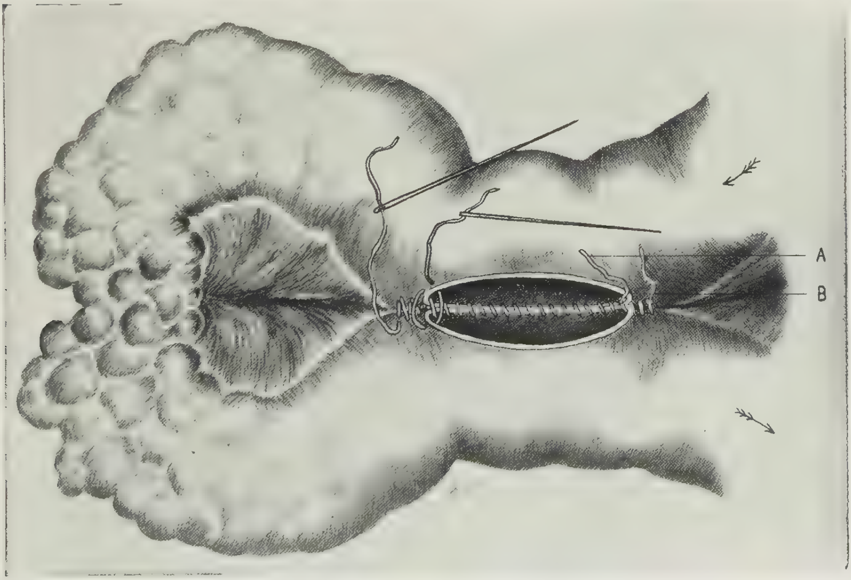


Fig. 3884.—Lateral Intestinal Anastomosis Short-circuiting an Inoperable Malignant Growth: _ A, Simple continuous overhand suture of all coats; B, continuous Lembert suture of outer coats. The intestinal current passes as indicated by arrows, "short-circuiting" the cancerous growth.

Illustration of the practical application of lateral entero-anastomosis, without partial enterectomy, may be had in connection with the operations of gastro-enterostomy (pp. 302–324).

An illustration of the use of this type of anastomosis, without enterectomy, may be seen in Fig. 3884 _ where an inoperable portion of the intestine is being short-circuited.

Instead of following out, in detail, the course above described and pictured, the technic may be modified in the following way: _ As soon as the axial incisions have been made, in the antimesenteric aspects of both pieces of bowel, through only the serosa and muscularis, the seromuscular margin of one piece of intestine is sutured to the seromuscular margin of the opposite piece (Fig. 3885). Then an incision is made through the mucosa of each piece of intestine with the blade of a sterilizing thermocautery _ or ordinary knife. After this the free margins of mucosa which lie nearer the seromuscular margins which have just been sutured, are sutured together over these margins. This is, in effect, three rows of sutures placed posteriorly (the weaker aspect of the entero-anastomosis). When the anterior or outer margins are sutured, all of the coats, including the separately divided mucosa, are included in the suturing _ just as in the technic covered in the body of this description.

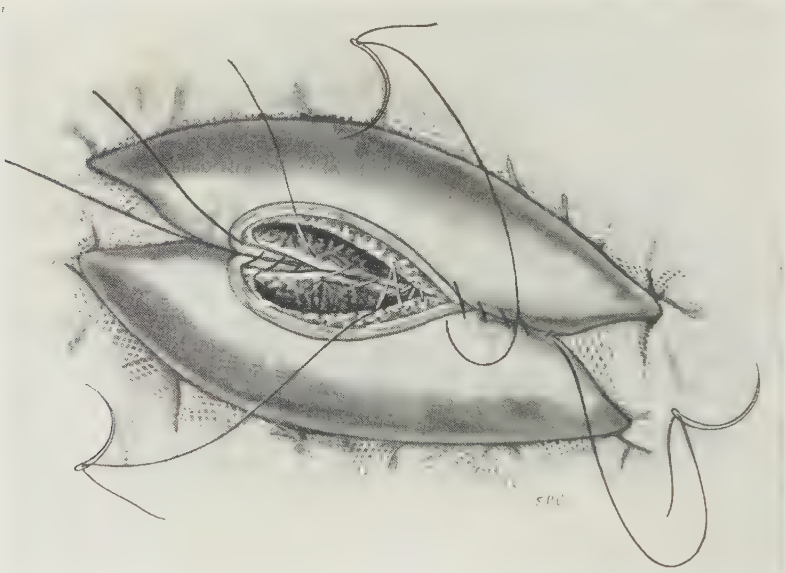


Fig. 3885.—An Alternate Method of Dealing with the Margins of the Anastomotic Openings in Lateral Entero-anastomosis _ by a Triple Tier of Sutures; _ Two laterally approximated loops of intestine are here shown _ their clamps being hidden by gauze. After the intestines have been incised the tiers of suturing are applied in the following order: _ posterior seromuscular Lembert suture _ posterior marginal of serosal and muscular coats _ posterior marginal of mucosal coats _ anterior marginal of mucosal coats _ anterior marginal of serosal and muscular coats _ and anterior seromuscular Lembert suture.

In Fig. 3886 is seen Moskowicz's method of performing lateral entero-anastomosis through the right-angled application of a knuckle of small intestine to the axis of the transverse colon.

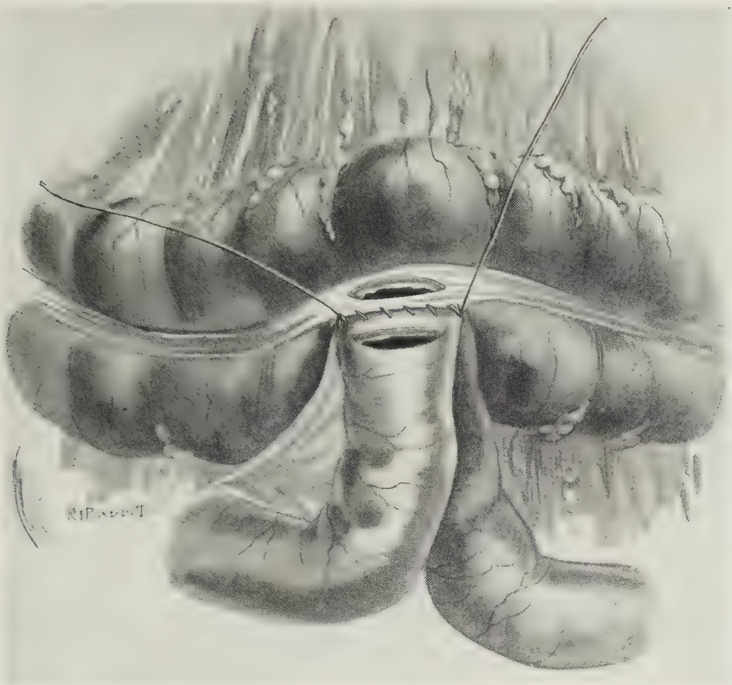


Fig. 3886.—Moskowicz's Method of Performing Lateral Ileocolostomy – between the ileum and transverse colon.

LATERAL ENTERO-ANASTOMOSIS BY BARTLETT'S CONTINUOUS MATTRESS-SUTURE

Description.—The special features of this method of suturing are, that it is, in effect a series of interrupted mattress-sutures, applied continuously –

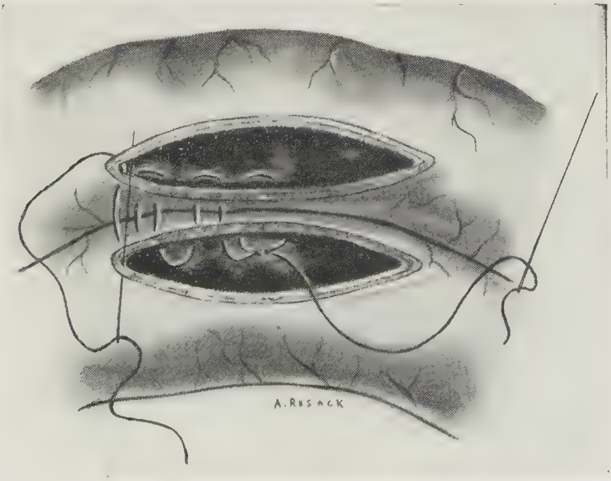


Fig. 3887.—Lateral Entero-anastomosis by Bartlett's Continuous Mattress-suture. The double needled suture has been begun in the middle, and is in the act of being continued around one end of the wound.

and that both of the ends of the intestinal wound, the hardest part of the suturing in methods of lateral anastomosis, are turned while the wound is rather readily accessible. The method might also, in practical effect, be considered a continuous Connell stitch applied to lateral entero-anastomosis – as the original Connell technic is an application of interrupted mattress-stitches, from within, to end-to-end entero-anastomosis.

Operation.—The parts to be sutured are brought into relationship and, while so held, the middle stitch, in the midposterior aspect of the wound, is placed by a double-needled thread – and tied (Fig. 3887). Thence onward, the needle on the left continues to repeat these stitches around the left end of the wound – and, similarly, the right needle, around the right end. Both the ends are turned before the anterior aspect of the wound is sutured – the suturing of which is finally accomplished in the same way as was the back and ends of the wound – except that the last emergence of the two needles is upon the outer aspect of the center of the anterior margin of the suturing, and the knot made by tying these two ends together there is then buried by a single Lembert stitch.

Comment.—This, like all forms of mattress-suturing, is much more easily and quickly applied by means of a Reverdin needle.

LATERAL ENTERO-ENTEROSTOMY BY SIMPLE SUTURING, AIDED BY DOUBLE CLAMPS, FOLLOWING PARTIAL ENTERECTOMY

Description.—Lateral entero-anastomosis following partial enterectomy involves three distinct steps – the excision of a portion of the intestinal tract – the closure by suture of the proximal and distal ends of the intestine left after the excision – and the reconstruction of the continuity of the tract by lateral anastomosis of the closed ends.

After partial excision of the intestine end-to-end entero-anastomosis and lateral entero-anastomosis are alternate methods of choice. While the former method, reconstructing the canal in natural continuity, seems the more natural and logical, there are many Surgeons who prefer to make the anastomosis by lateral union after closing the cut ends – and who consider that the union can, mechanically, be made more perfect with a smaller percentage of leakages – even claiming that when leakage does occur in lateral anastomosis it is more apt to come from the closed ends of the intestine than from the site of anastomosis. Makins writes, speaking of lateral anastomosis, with closure of the cut ends of intestine, – ". . . and, lastly, experience has abundantly proved the risks from leakage at the line of suture (meaning the site of lateral anastomosis) to be far less than in the case of axial unions. . . . In enterectomy with lateral union, however, it must be allowed that the risk of leakage is from the blind terminal ends, which, in a lesser degree, constitute the danger in axial unions."

Wherever the parts of the intestine can be brought into easy relationship of their antimesenteric aspects, and the mechanical steps of lateral union, following excision, can be carried out, and whether the parts to be anastomosed are two pieces of small intestine, two pieces of large intestine, or a piece of a small and of a large intestine, lateral entero-anastomosis is applicable – and may be chosen in place of end-to-end entero-anastomosis.

While lateral entero-anastomosis without excision may be, mechanically, the safest type of bowel union – and lateral entero-anastomosis following partial enterectomy be the next safest – yet end-to-end entero-anastomosis is probably the most frequently employed method of intestinal anastomosis of the small bowel, where the pieces of intestine are movable, have mesenteries, and the operation is not performed in conjunction with some other technic calling for a lateral union (such as lateral jejunojejunostomy following gastro-enterostomy).

Operation.—As mentioned above, the completed operation consists of three steps:—

(*A*) Partial Enterectomy:—This carried out exactly as already described and pictured under that heading (pp. 666–671).

(*B*) Closure of the Proximal and Distal Ends of the Intestine by Suture:—Quite a number of methods of accomplishing this are in use—of which the following represent those most frequently employed:—

(**1**) Closure of the Intestinal Ends by Marginal Through-and-through Sutures, Reinforced by Lemberts: The open end of the intestine is held between the thumb and first finger—or between two non-penetrating tractor sutures placed near the margins, paralleling the borders, which are then first whipped together by an overhand, through-and-through fine chromic catgut suture of all the coats (interrupted or continuous)—followed by an invagination of this line of suturing by an outlying tier of silk Lemberts (interrupted or continuous)—the technic being shown in Fig. 3888.

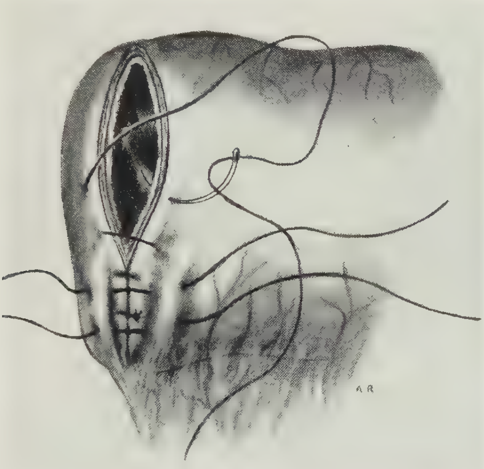


Fig. 3888.—Closure of the Intestinal Ends by Marginal Through-and-through Suture Reinforced by Lembert Suturing.

(**2**) Closure of the Intestinal Ends by a Penetrating or Non-penetrating Marginal Purse-string Suture, Followed by an Invaginating Purse-string Suture of the Outer Coats: A strong silk or Pagenstecher purse-string suture is carried marginally through all the coats—which is then tied in a square knot, thereby entirely closing the intestinal lumen. This knotted end of the tied intestine is then seized with forceps and depressed or invaginated within itself—and, while so held, is buried in its invaginated position by a second tier of purse-string suturing of silk passing through serosa, muscularis, and part of the submucosa. The technic is shown elsewhere. A non-penetrating purse-string suture is seen in Figs. 3889–3891.

(**3**) Closure of the Intestinal Ends by Marginal and Lembert Sutures While Still Grasped by the Clamps Which Held Them During Partial Enterectomy: The clamps applied before excision are left *in situ*—the sections having been made far enough from the clamps to leave sufficient length of intestine beyond for suturing. The margins are whipped together with an overhand, through-and-through silk or Pagenstecher suture – after which this tier is buried in by outlying silk Lemberts.

(4) Invagination of the Intestinal Ends, After the Use of the Enterotribe and Ligature: A clamp is applied on each side of the portion of the intestine to be excised – and to the outer side of each of these two clamps, another clamp is applied. Between the two sets of clamps on either side, the intestine is crushed with an enterotribe (Fig. 3892). The mesentery corresponding with the intestine to be excised may also be crushed with the same instrument. The crushed tracts are then firmly ligated with strong silk, or Pagenstecher. Finally, each of the two ligated ends of intestine is invaginated within its own end of the bowel, and buried there by, first, one tier of Lemberts – and then, a second tier of Lemberts – as shown in Figs. 3893 and 3894.

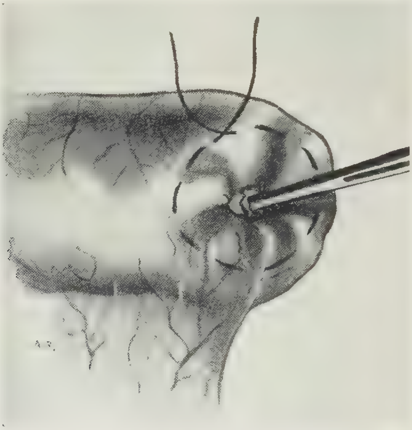
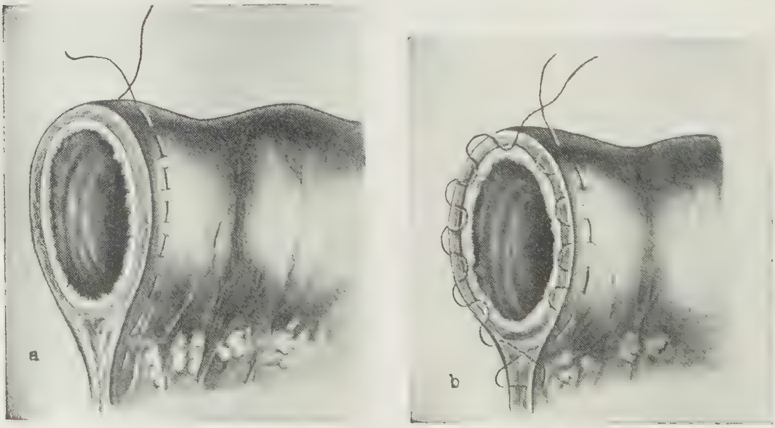


Fig. 3889.—Closure of the Intestinal Ends by a Bag-mouth Ligature, Followed by an Invaginating Purse-string Suture of the Outer Coats.



Figs. 3890 and 3891.—Non-penetrating Purse-string Suture of the Intestine: – a, Surface view; – b, sectional view

(5) Moskowicz's Method of Closing the Intestinal Ends by Invagination: The bowel is clamped by Moskowicz's slender clamps on each side of the part to be removed. The intestine is then crushed with an enterotribe between the two clamps – the line of crushing lying near each clamp. The excision is

then made through this crushed tract by means of a thermocautery. Each clamp then depresses its severed end invaginatingly toward the lumen of the bowel _ while a tier of Lemberts buries in the end _ the clamp being removed after the last stitch is placed, but before it is tightened. It is safer to reinforce this first tier of Lemberts by a second tier. The technic is shown in Fig. 3894.

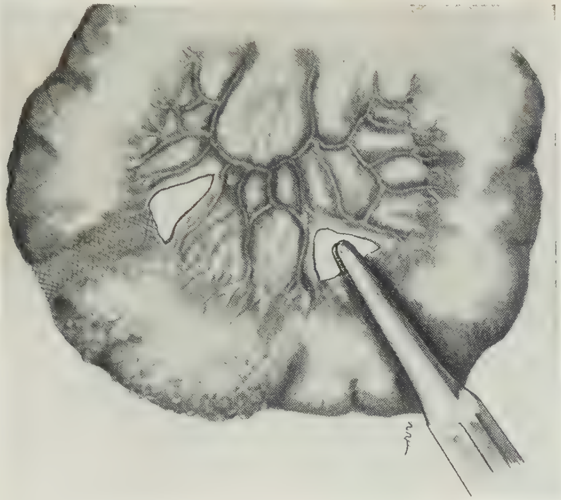


Fig. 3892.—Doyen's Method of Invaginating the Intestinal Ends, After the Use of the Enterotribe and Ligature _ Preparatorily to Side-to-side Anastomosis of the Closed Ends _ I; _ Transverse crushing of a portion of intestine, to each side of some growth _ the ends of the crusher passing into openings in the mesentery.

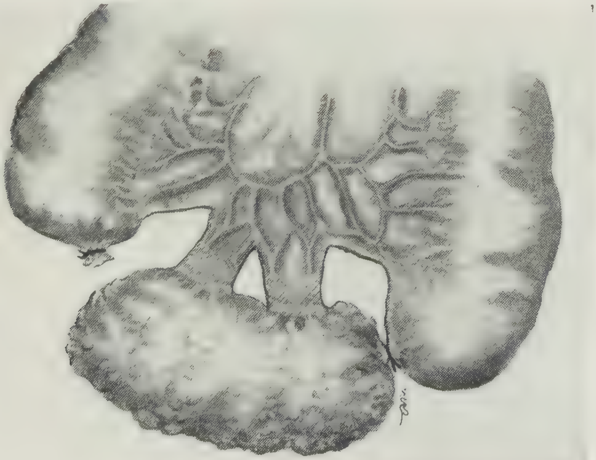


Fig. 3893.—The Same _ II; _ The intestinal loop has been doubly clamped, ligated, and is being divided The crushed tracts of mesentery will be similarly ligated and divided.

(6) Klapp's Method of Closing the Intestinal Ends: In this procedure the intestine is similarly seized with Moskowicz's slender clamps, crushed

and divided — after which, according to the understanding of the Author, the part of the intestinal end protruding beyond the clamp is closed with suture — and then the clamp is twisted upon its long axis, rolling the intestinal end with it, until more than a complete revolution is made — when the adjacent surfaces are sutured together with stitches which pass through the serosa, muscularis, and part of the submucosa. By this method, Klapp claims that not only is the end closed, but that the margins are bulwarked against being bulged open by the intestinal wall against which it has been rolled.

(**7**) Other Sutural Methods of Closing the Intestinal Ends, Aided by Graser's Fenestrated Clamps, and Terminating by Invaginating these Ends by Lembert Suturing: In Fig. 3895 is shown a partial enterectomy, where the intestine has been seized with Graser's fenestrated clamps just outside of the region to be excised. On the left a preliminary through-and-through continuous suture is being placed, through the window of the clamp. On the right the walls of the intestine are being preliminarily brought together with a cobbler stitch. Following these first tiers of terminal suturing the ends will be invaginated toward the lumen of the bowel and buried by one or more rows of Lembert suturing

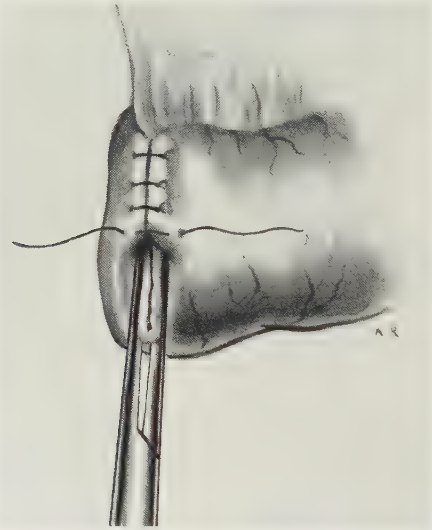


Fig. 3894.—Moskowicz's Method of Closing the Intestinal Ends by Invagination.

(*C*) Lateral Entero-anastomosis: Lateral anastomosis of one intestinal end with another, following the excision of the intervening piece of intestine, is applicable to both the small intestine (jejunum and ileum) and to the parts of the large intestine which are sufficiently movable. In the case of the large intestine, it is the method of choice (whether preceded by partial enterectomy or not), as union by end-to-end anastomosis is more difficult and less safe than in the case of the small intestine, owing to the irregularities of the large intestine, the scybalous nature of its contents, the relative immobility of much of the large intestine, and the difficulty of making a union safe against leakage, and against the strain of fecal masses.

Lateral entero-anastomosis of the small and of the large intestine will be considered.

(*a*) Lateral Entero-anastomosis of the Small Intestine: After the excision of the indicated portion of the intestine has been accomplished _ and the cut intestinal ends closed by one of the methods just described in detail _ the antimesenteric aspects of the two portions are seized by two single clamps, and brought into contact. From this point on the technical details of anastomosis do not materially differ from those already described and pictured under the operation of lateral entero-enterostomy, by simple suturing, aided by double clamps, *without* preceding partial enterectomy upon pp. 696–700). It is of practical importance that the anastomosing incision be made as nearly as possible in the midantimesenteric aspect of each piece of intestine, as the resulting blood-supply is better _ and, owing to the freedom of movement of the small intestine, this is usually readily accomplishable.

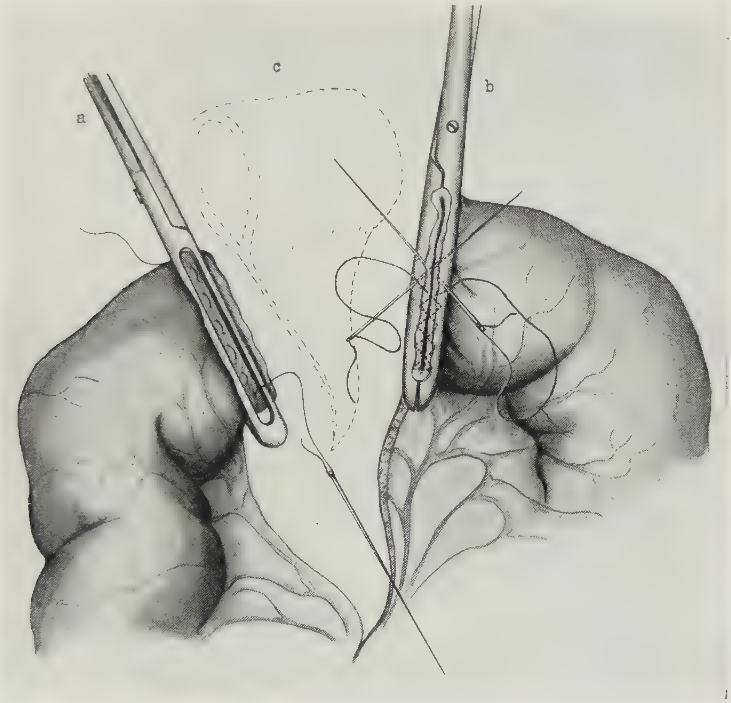


Fig. 3895.—Partial Enterectomy, Followed by Lateral Entero-anastomosis, Aided by Graser's Fenestrated Clamps: _ **a,** One clamp grasping the margin of the intestine, along which one limb of the excision has passed, and through the fenestrum of which an ordinary through-and-through continuous suture is closing the end; _ **b,** the opposite clamp, to show a different technic, is turned through a quarter circle, to illustrate the use of the cobbler's stitch (threaded upon a needle at either end), carried through the window of the clamp; _ **c,** the incised segment of intestine and mesentery. Both ends will be invaginated with Lemberts

Having brought into easy relationship the closed and laterally clamped bowel ends, approximate these ends so that they overlap about 7.5 to 10 cm. (3–4 inches), with their antimesenteric aspects in contact. The lateral aspects of the coils of intestine may be held in approximation by the hands of an Assistant during the suturing _ but the contact can be made more satisfactory, and the likelihood of leakage less, by the use of special intestinal clamps. Place a tier of continuous Lembert suturing of silk, carried upon a curved needle held in a needle-holder, along what will be the posterior line of union between the serous surfaces — extending the line of suturing out at either end, in a somewhat elliptic form, beyond the limits of the future incision — leaving one end of the suture, after knotting, long and free — and the other end, also after half-knotting, long and threaded upon the needle. (See Fig. 3896.) Incisions in the long axis of both pieces of intestine are now made opposite each other in the corresponding aspects of the bowel ends — and sufficiently far from the posterior suture line to leave two free edges for suturing — and equidistant from what will form the anterior suture line of the serous surfaces. These incisions will begin and stop short of reaching the outer limits of the surrounding Lembert suture line which will enclose them. The corresponding free margins of the wounds are now sutured with continuous overhand fine chromic catgut suture, carried in a curved needle held in a needle-holder. Begin the suturing at the right end of the posterior aspect (furthest from operator) — knot the suture and leave one end of the thread free — and continue the suturing toward the operator until the posterior lips are united. Having reached the limit of the posterior aspect of the opening, the direction of the suturing now changes and is made to traverse

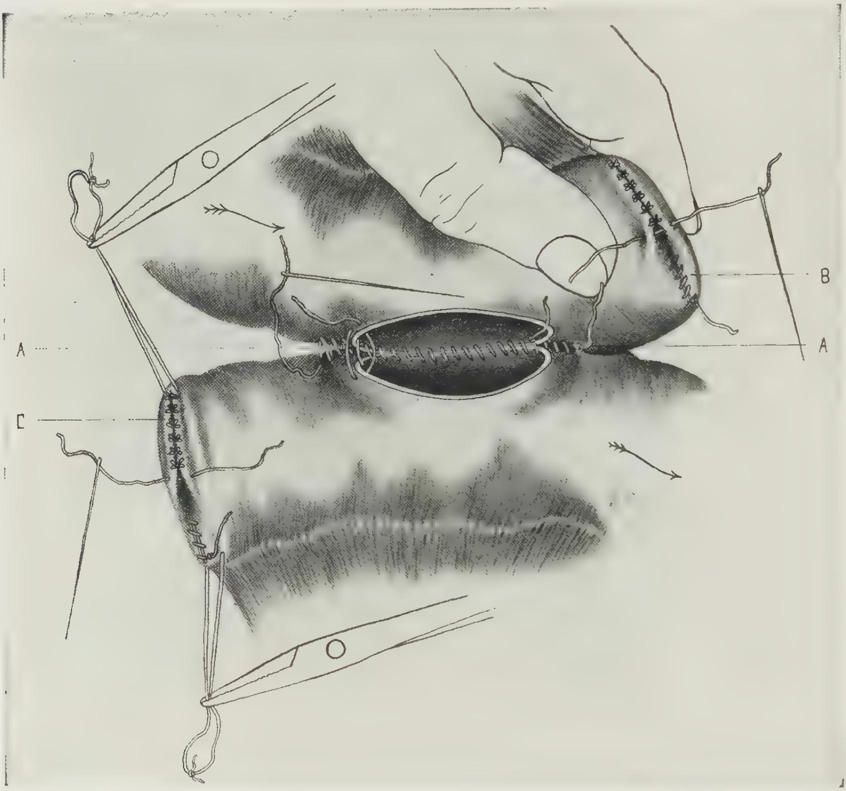


Fig. 3896.—Lateral Intestinal Approximation by Simple Continuous Overhand Suturing of all Coats, Followed by Interrupted (or Continuous) Lembert Sutures of Outer Coats — I; — Manner of placing posterior sutures: A, Showing manner of placing sutures along posterior aspect and at ends of incisions; B, manner of holding end of intestine between thumb and index while placing sutures; C, manner of holding the ends with temporary traction sutures passed through outer coats while invaginating.

the anterior aspect of the wound, similarly whipping together the anterior lips of the intestinal incisions from left to right, away from the operator – until the point of beginning is reached, when the end from which the needle has just been withdrawn is knotted to the end previously left free – thus

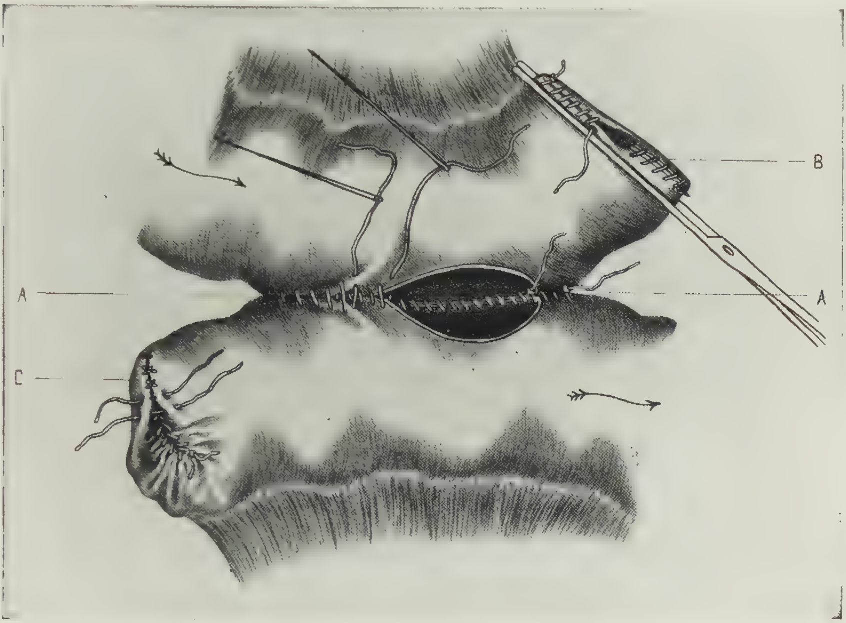


Fig. 3897.—Lateral Intestinal Approximation by Simple Continuous Overhand Suturing of all Coats, Followed by Interrupted (or Continuous) Lembert Sutures of Outer Coats – II; – Manner of placing anterior sutures: A, Showing manner of carrying suture around ends and along anterior aspect of incisions; B, manner of holding end of intestine with clamp-forceps while suturing; C, manner of closing end of intestine with purse-string suture preparatory to placing final tier of end sutures.

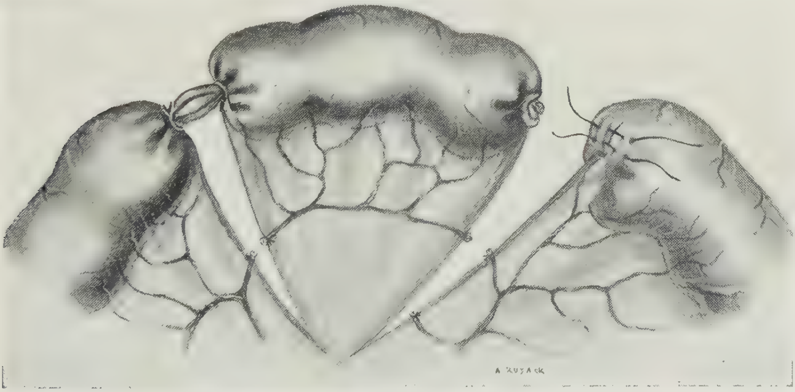


Fig. 3898.—Lateral Entero-anastomosis of the Small Intestine – I; – Illustrating an exceedingly simple method of isolating the parts to be dealt with by quadruple ligature – double silk or Pagenstecher ligatures being tied at each end of the part to be excised, after compression by an enterotribe or not – the piece of intestine and its mesentery being then excised – the proximal and distal ends of the main intestine, already ligated, being invaginated by Lemberts – and the resulting intestinal ends about to be brought into antimesenteric relationship ready for lateral anastomosis.

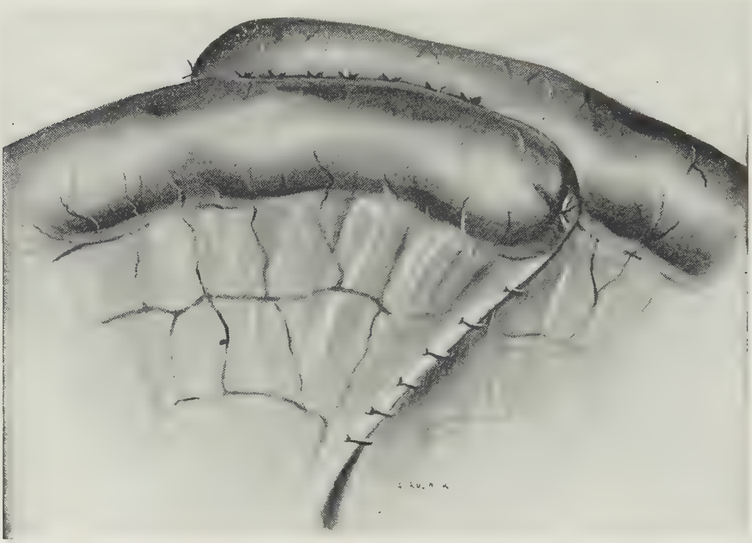


Fig. 3899.—The Same _ II; _ The intestinal ends have been brought into relationship, side to side _ and slightly turned upon their long axes so that their antimesenteric aspects come into contact _ after which their anastomosis is accomplished by marginal and by seromuscular suturing in the usual manner.

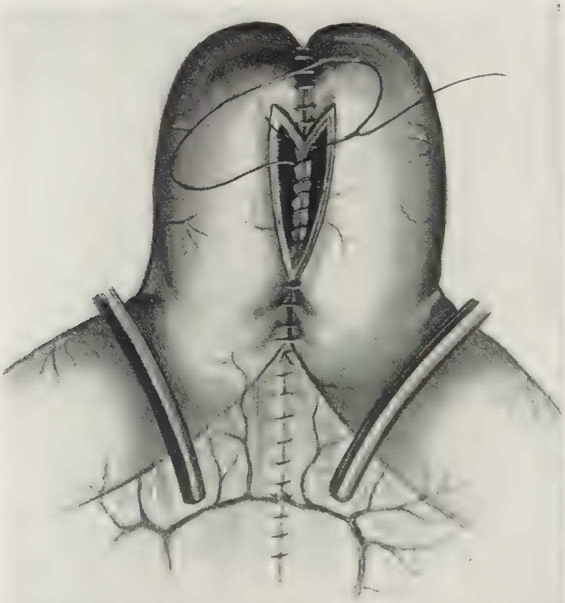


Fig. 3900.—Apposition of the Intestinal Ends, Lying in the Same Direction, by Lateral Entero-anastomosis; _ The two ends of the divided loop of intestine have been ligated and invaginated _ and these ends are now being laterally anastomosed by double posterior and anterior tiers of sutures in the usual manner.

completely approximating the lips of the openings throughout. The threaded needle of the original serous suture, which had been temporarily dropped, is now taken up _ and this line of continuous Lemberts is carried on around the outside of the line uniting the edges, at the same distance from their edge as the posterior serous line passed _ until the free end of line of serous suture. left at starting, is reached, when they are knotted together, _ which completes the union between the intestines. (See Fig. 3897.) The mesentery is now sutured as indicated.

A somewhat differently accomplished, but exceedingly simple method of lateral entero-anastomosis, is shown in Figs. 3898 and 3899 _ easily understandable from the combined legends and picturing.

The intestinal ends to be laterally anastomosed, following either partial excision or simple division, are sometimes differently approximated, according to the predilection of different Surgeons _ though none of the differences interfere with the underlying principles involved. Three different arrangements of the intestinal coils are shown in Fig. 3899, already quoted _ and in Figs. 3900 and 3901. The method illustrated in Fig. 3901 is the one most frequently adopted. But, apparently, it makes no difference, ultimately, how antiperistaltically the intestinal ends may be left immediately after the anastomosis _ for they finally assume a relationship with each other in which the channel is but little distorted _ as is indicated in Figs. 3902-3904 and in Figs. 3905 and 3906.

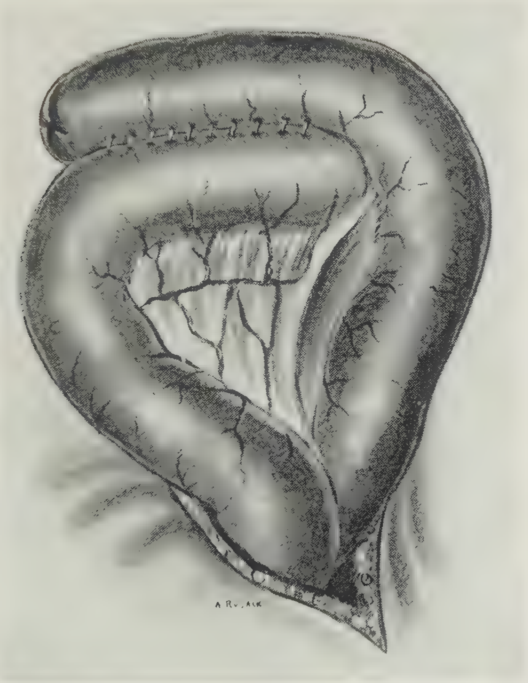
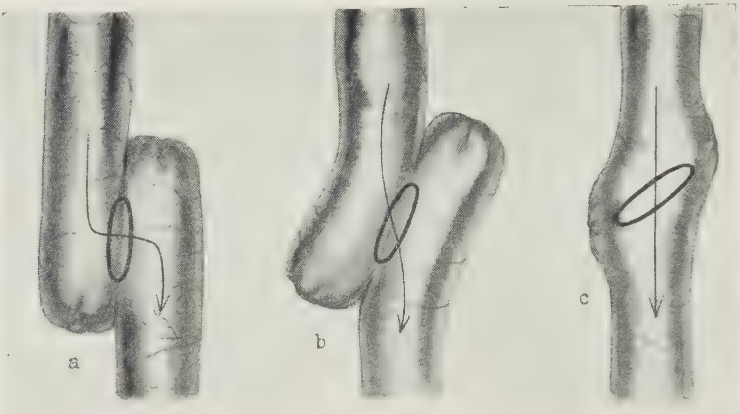
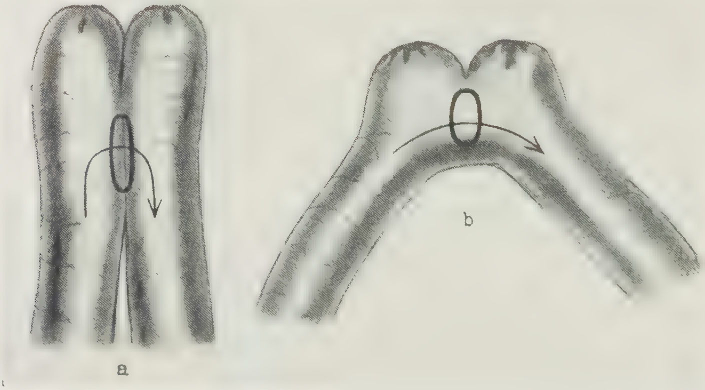


Fig. 3901.—Lateral Intestinal Anastomosis of One End of the Loop Above the Other _ Following Partial Enterectomy _ following the ligation or suturing _ invagination _ and reinforced suturing of the divided ends.

(*b*) Lateral Entero-anastomosis of the Large Intestine: In carrying out lateral anastomosis in the large intestine, the severed ends of the large bowel should be secured with unusual care by one of the most reliable of the methods mentioned in the closure of the intestinal ends. It may be difficult to apply either the method of crushing and ligature, or of a purse-string suture in a large, thick, and irregularly contoured large bowel. Probably the safest method is to apply three tiers of suturing, of strong silk or Pagenstecher – the first being a through-and-through tier of the margins – the second, a tier of Lemberts – and the third, a second tier of Lemberts, superimposed upon the preceding tier. The anastomosing incisions into the intestinal ends should be made axially through the anterior muscular band (owing to its resistance) of the large bowel. To accomplish desirable approximation of the lateral aspects of the bowel ends without, at the same time, tension upon the site of anastomosis, will necessitate partial rotation of one or of both ends of the bowel, upon the intestinal axis – but this slight degree of twisting will soon right itself, following the operation (as suggested by the remarkable postoperative



Figs. 3902–3904.—Showing the Immediate – Intermediate – and Final Relationships of the Intestinal Ends, Following Lateral Entero-anastomosis Accomplished by the Usual Technic, with the Intestinal Ends in Opposite Directions – illustrating the gradual assumption of an almost straight course in the intestinal tube.



Figs. 3905 and 3906.—Showing the Immediate and Ultimate Relationships of the Intestinal Ends, Following Lateral Entero-anastomosis Accomplished by Side-to-side Approximation, with the Intestinal Ends in the Same Direction.

changes which take place, as shown in Figs. 3902–3904, and in Figs. 3905 and 3906, already quoted).

Resection of the large intestine, followed by anastomosis of the ends (which is practically always by the method of lateral approximation of the closed ends) is very much more of an operation than the corresponding operation upon the small intestine — and, owing to the difficulties and to the larger proportion of untoward results, several methods have been evolved for this purpose. The method probably most frequently employed the analogue of the one used in the small intestine — will be here described. And under the more special Operations Upon the Colo-recto-anal Region will be considered special procedures, usually in two or more stages, for the partial excision of the large intestine, followed by the anastomotic reconstruction of the large bowel.

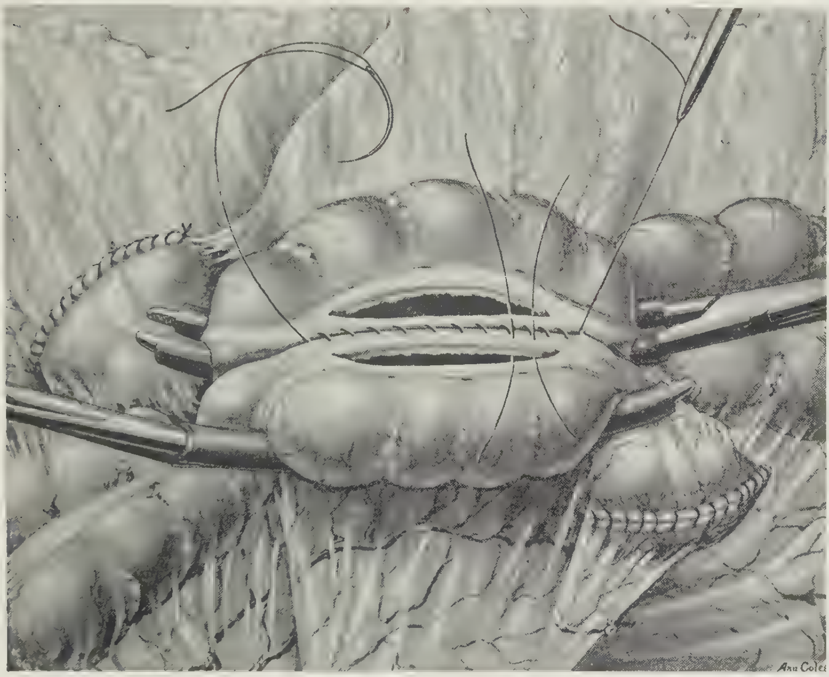


Fig. 3907.—Lateral Entero-anastomosis of the Large Intestine (Transverse Colon), Following Partial Enterectomy, with Closure of the Ends of the Colon; — The omentum has been displaced upward — and the divided margins of the colonic mesentery have been crossed over each other. The intestinal axes have been rotated, by clamps, so as to bring their tinea libra, or anterior muscular band, into contact — through the center of which the anastomotic incisions have been cut — and union is being accomplished by marginal and by seromuscular sutures.

In anastomosing the parts of the large intestine the technic is, naturally, easiest where the mesentery is longest and the part can be delivered outside of the abdomen — and more difficult where it is shortest, and the work must be done within the abdomen, or where some special form of mobilization must be first performed to render the intestine accessible to the necessary manipulation. The sacculi, appendices epiploicæ, teniæ, limited mesentery, and omentum, all add to the difficulties. The transverse colon and sigmoid flexure afford greater range for operation than do the more bound-down ascending, hepatic, and splenic portions.

The operation of anastomosis is, in the main, the same as that described for the small intestine (v. pp. 689–695) – differing only in respect to the peculiar conditions and difficulties connected with bringing the parts into easy apposition for the lateral entero-enterostomy. The disposal of the parts and lines of section are shown in Fig. 3907. Each of the closed ends is grasped by curved intestinal forceps in such a manner that the forceps will not compress the sutured ends, and that they will be applied far enough from the ends to allow the outer aspects of the opening to be at least 2.5 cm. (1 inch) or more from the ends – and admit of an incision of about 5 cm. (2 inches) in each piece of the colon. Thus clamped, the opposite portions of the colon are rotated slightly upon their axis and brought into such relationship that their anterior teniæ will be in contact. The posterior row of silk or Pagenstecher sutures is carried through the serosa, muscularis, and part of the mucosa – the suture being knotted at its end of beginning – and half-knotted and left threaded at its opposite end. Both teniæ are then incised in their center for about 3.7 cm. (1½ inch). The through-and-through marginal suture of chromic catgut is then placed through the posterior borders of the opening – the suture, similarly, being knotted and left long at its initial end – and half-knotted and left threaded at its opposite end. Finally, the marginal suture is taken up and continued around the anterior borders of the opening – after which the posterior seromuscular suture is similarly carried around the anterior aspect of the anastomosis.

The abdomen is usually closed without drainage.

ENTERO-ANASTOMOSIS BY END-TO-SIDE IMPLANTATION (TERMINO-LATERAL ENTERO-ANASTOMOSIS)

Description.—This technic somewhat resembles nature's right-angled junction of the ileum with the cecum – and its most pronounced field of application is in the operation of ileocolostomy. It is also employed in colocolostomy – and Kocher uses an end-to-side jejunogastrostomy following partial gastrectomy (having had only one leakage in 85 operations of this nature). Following excision of the cecum the jejunum may be united with the transverse colon by end-to-side ileocolostomy (v. p. 812).

Operation.—Three chief methods of accomplishing the anastomosis have been worked out – the end-results in all being practically the same. The first two methods are interchangeable.

(*a*) End-to-side Union of the Ileum with the Transverse Colon: The selected portion of the colon, after being freed of contents by "milking," is clamped axially by a curved clamp – and the free end of the ileum, transversely, by a straight clamp – after which the parts are brought into convenient relationship for anastomosis (Fig. 3908). An axial incision is made in the anterior tænia of the transverse colon, calculated to accommodate the divided end of the ileum. Beginning at the (patient's) right end of the incision, upon the borders of opening further from the Operator, marginal chromic catgut suturing (interrupted or continuous) is placed through all the coats of the free margins of openings, along their posterior aspect – and then along their anterior aspect, thus entirely closing the opening. A second tier of silk or Pagenstecher Lembert suturing is now carried through serosa, muscularis and part of the submucosa, just outside of the marginal suturing. This is readily enough placed along the surfaces nearer the Surgeon – but when the surfaces further away are reached, the ileum must be displaced upward, to render this region accessible. If, in advance, this latter inconvenience is considered too great to insure satisfactory union, the method next to be described should be adopted.

(*b*) End-to-side Union of the Ileum with the Ascending Colon (Kocher's Technic): The ileum is divided between double clamps, the division being made near to the clamp which is to control the end of the ileum that is to be manipulated during the first part of the anastomosis. The ascending colon is clamped axially, exposing the *tenia* _ (the cecum may have been excised and the lower end of the ascending colon closed by suture). By turning the clamp which grasps the ileum through a quarter-turn to the right, the posterior transverse aspect of the ileum will be brought into relationship with the axial margin of the muscular band upon the ascending colon, in the center of which the incision into the colon will be made. The posterior tier of silk or Pagenstecher stitches through serosa, muscularis, and part of the submucosa is placed. The incision into the colon is then made, the marginal hold of the clamp upon the ileum relaxed, and another hold taken further back _ and the posterior marginal tier of through-and-through chromic catgut sutures placed (Fig. 3909). This marginal tier of sutures is then continued anteriorly until the opening is entirely shut off _ after which the posterior tier of sero-musculo-submucosal sutures is, likewise, continued on around the anterior aspect of the anastomosis.

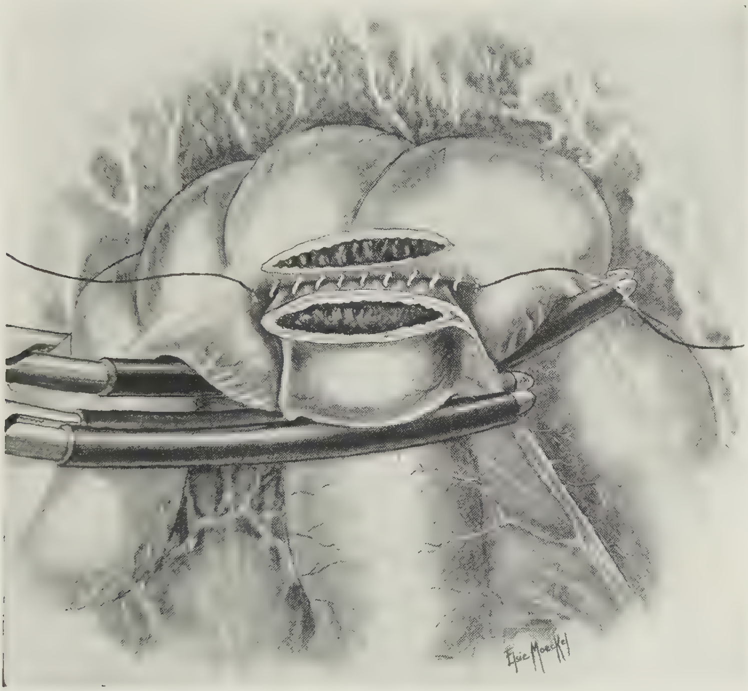


Fig. 3908.—End-to-side Entero-anastomosis Between the Ileum and Transverse Colon; _ The parts have been clamped and brought into apposition _ and the posterior seromuscular line of suturing has been carried, uniting the surface of the posterior lip of the colonic incision with the surface of the posterior aspect of the end of the ileum. The margins of the two openings will then be united by a through-and-through suture _ after which the posterior seromuscular suture will be continued around the anterior aspect of the opening. The omentum has been thrown upward _ and the mesenteries of the colon and ileum are put upon the stretch.

(*c*) End-to-side Union of One Piece of Small Intestine with Another (Maylard's Technic): A suture, with a needle at each end, is carried, by two or

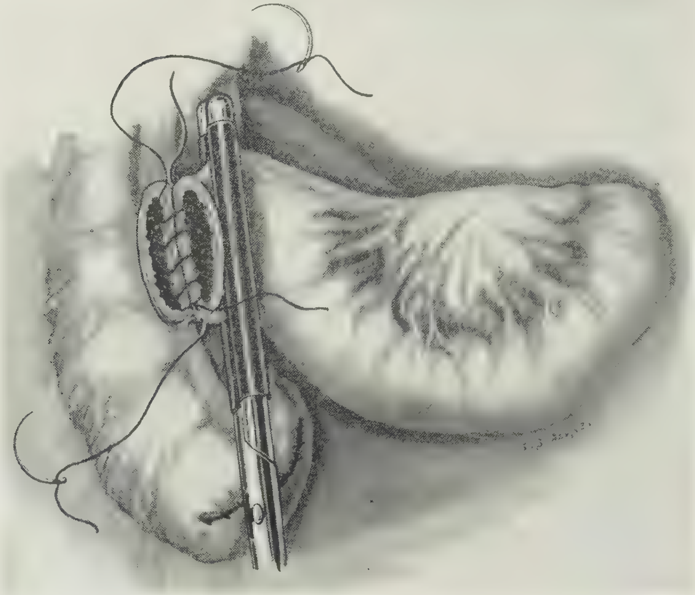


Fig. 3909.—End-to-side Entero-anastomosis Between the Ileum and the Ascending Colon; _ The clamped end of the ileum has been brought into relation with the axial aspect of the muscular band of the ascending colon (also usually clamped axially) _ in the center of which band an incision has been made corresponding with the open end of the small intestine. The intestinal union is accomplished by a posterior seromuscular and posterior marginal row of sutures, here seen _ after which both tiers will be extended around the anterior aspect of the anastomosis.

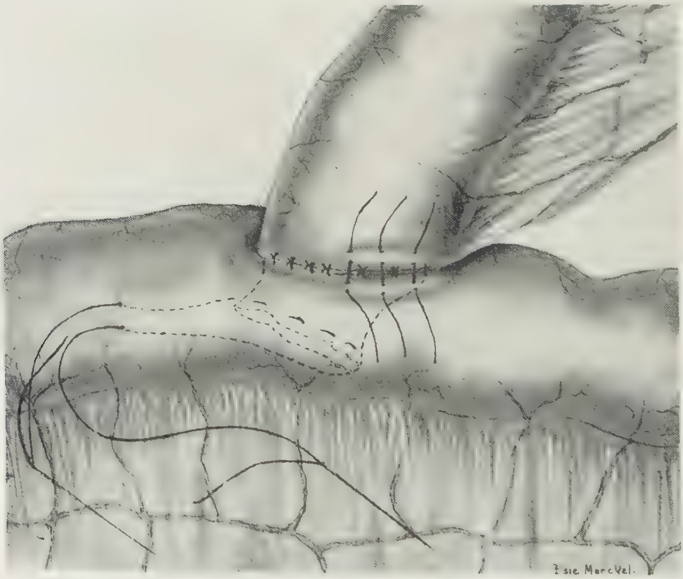


Fig 3910.—End-to-side Union of One Piece of Small Intestine with Another _ Maylard's Technic; _ The free end of one segment of bowel is being drawn, by means of two temporary tractor sutures, through the incision in the antimesenteric aspect of another segment _ after which the margins of the intussuscipiens are first sutured to the sides of the intussusceptum, by stitches which penetrate all the walls of the former and the outer coat of the latter _ this tier of suturing being then reinforced by a tier of Lemberts. The tractor sutures are finally withdrawn.

three punctures, through one side of the free end of the piece of intestine to be implanted within the other _ to serve as temporary tractors. Into the antimesenteric aspect of the portion of intestine to receive the implant an incision is made. The two needles are then carefully carried through the incision, and onward for 2.5 cm. (1 inch) or more _ and then are made to pierce the intestinal wall, from within outward. By means of the on-following tractor sutures the free end of intestine to which they are attached is drawn into the incised intestine for approximately 2 cm. ($\frac{3}{4}$ inch) (Fig. 3910). A clamp applied to the tractor sutures just where they emerge from the intestine will serve to hold the intussuscepted piece in position during the suturing. The paramargins of the incision are then sutured to the sides of the indrawn piece of intestine by sutures which pass through serosa, muscularis, and prat of the submucosa, but which do not penetrate the lumen, nor take in the free margins of the incised intestine. This line of seromuscular suturing, for safety's sake, may be reinforced by a second tier of the same kind of suturing. Upon the completion of the operation, if the temporary traction suture cannot be drawn out by one end, the two limbs of this suture are cut short and are worked back into the intestine. If considered necessary the needle punctures made for the tractors may be closed with a seromuscular stitch.

END-TO-END ENTERO-ENTEROSTOMY BY PERFORATING MATTRESS-SUTURES KNOTTED WITHIN THE LUMEN

CONNELL'S METHOD

Description.—Interrupted silk mattress-sutures are so carried through all the coats of the intestinal ends as to bring all the knots, when tied, to lie within the intestinal lumen. No reinforcing tier of sutures is employed.

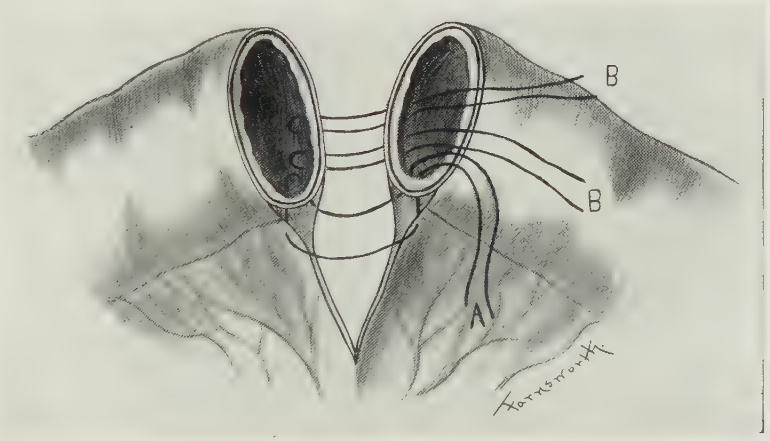


Fig. 3911.—End-to-end Entero-enterostomy by Connell's Method _ I: _ A, Mesenteric stitch; B, B, interrupted mattress-sutures through all coats of both ends of intestine knotted within the lumen.

Operation.—The mesenteric, the most important, suture is placed in the following manner (Fig. 3911, A): _ The needle (calculating that the stitches are 3 mm.—$\frac{1}{8}$ inch—apart and the same distance from the free edge of the intestine) passes through all the coats of one end of the intestine, from within outward _ into the free space between intestine and leaf of the mesentery _ through this leaf from within outward _ over to the opposite leaf of the mesentery _ through this from without inward _ through the free space between the mesenteric leaf to the intestine – through all the coats of the other end of the intestine, from without inward – thence, returning, the needle and thread take a corresponding course – to emerge parallel with the thread of entrace, within the lumen of the original end of the intestine – ready to be tied. This stitch approximates the leaves of the mesentery to the barrel of the intestine, and the two ends of the intestine to each other.

Four traction sutures are inserted, as shown in Fig. 3912, dividing each intestinal circumference into thirds, for the purpose of aiding in the mechanical insertion of the remaining mattress-sutures. Two are placed as indicated at A and B, Fig. 3912. These pass through all the coats of both ends of the intestine. By traction upon them the walls of the intervening third of the end of each piece of intestine are put upon the stretch and made parallel, thus rendering them easy of access for the placing of the sutures for that third. Upon the completion of this third traction sutures C and D are brought together and drawn in the opposite direction from B – which will make the second third of the intestinal margins occupy the position originally occupied by the first third. The last third (AC and AD) is brought into line and sutured in the same way, with the modification to be mentioned. The sutures pass through all the coats of both of the intestinal ends, as shown in Fig. 3911, B, B, and in Fig. 3912, E, and are knotted as soon as placed.

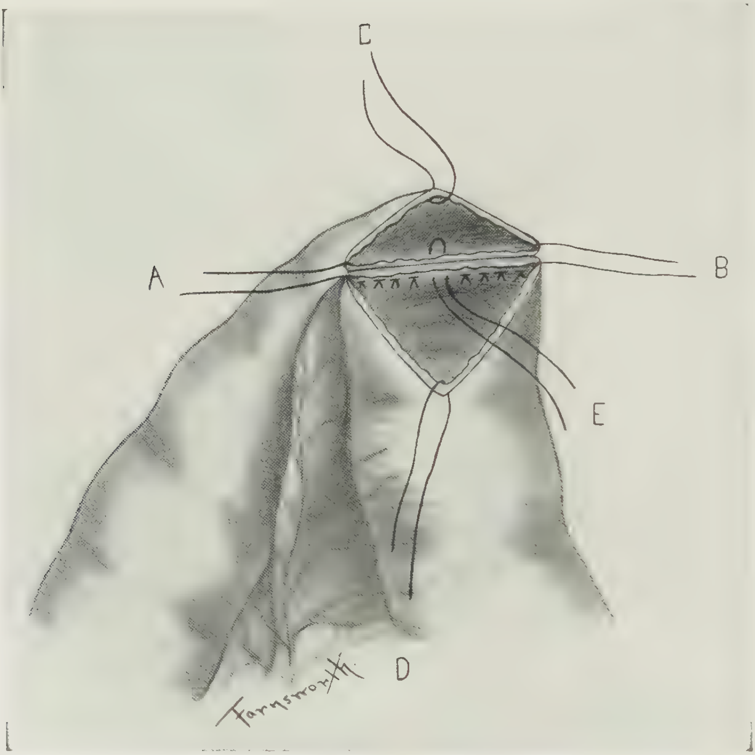


Fig. 3912.—End-to-end Entero-enterostomy by Connell's Method – II: – A, B, Traction sutures drawing margins of first thirds of intestines parallel; C, D, traction sutures to be used in paralleling remaining thirds of intestinal margins; E, one of the interrupted mattress-sutures placed ready to be tied.

The suturing is thus rendered very easy until the circumference has been nearly traversed.

In the suturing of the last third there is greater mechanical difficulty owing to the lessened working room. It is best to place the sutures of this third before tying them. When this is done — all are tied except the last one. The closure represented by the last stitch is accomplished in one of two ways: — (*a*) The author of the technic completes the tying of the last mattress-stitch by inserting a threaded needle, eye first, between two sutures of an opposite aspect of the circumference (Fig. 3913) — the eye-end of the

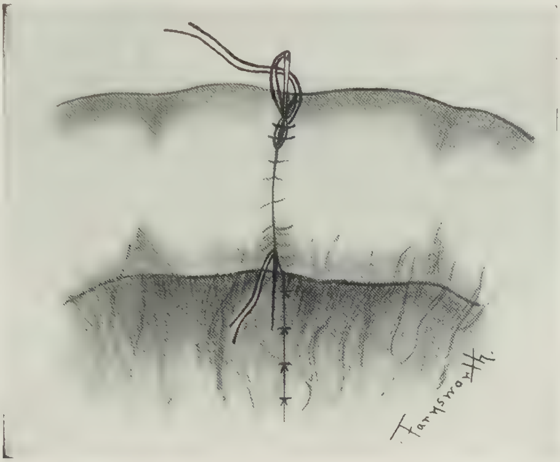


Fig. 3913.—End-to-end Entero-enterostomy by Connell's Method — III; — Insertion of needle, eye-end first, through interval between sutures — projecting through interval left by yet untied last mattress-suture — the threads of which are within loop made by needle and its thread, ready to be drawn out through place of entrance of eye-end of needle.

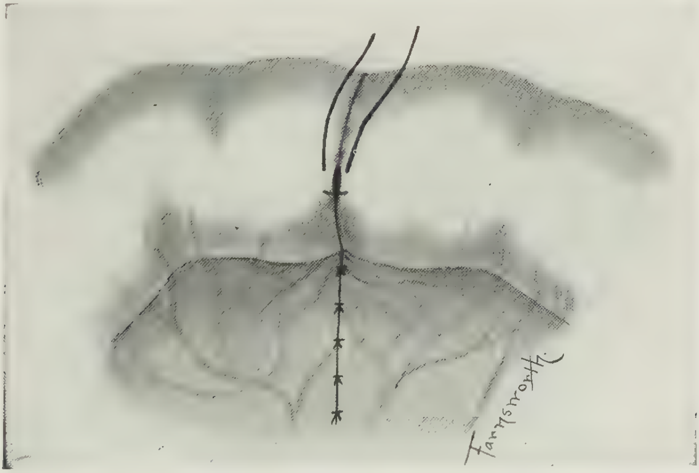


Fig. 3914.—End-to-end Entero-enterostomy by Connell's Method — IV; — Gould's method of closing interval left by last mattress-suture in Connell's operation by means of a seromuscular mattress-suture. (Redrawn from Gould.)

needle is protruded through the opening left by the last stitch _ the two threads composing this last stitch are then carried through the noose made by the shaft of the needle and its double thread _ after which the needle is withdrawn, carrying the two threads of the last stitch with it _ which are then knotted and cut short _ during which process the walls of the lumen are approximated _ and regain their normal relation upon the cutting of the knot _ the serosæ separated by the entrance of the eye-end of the needle also coming together.

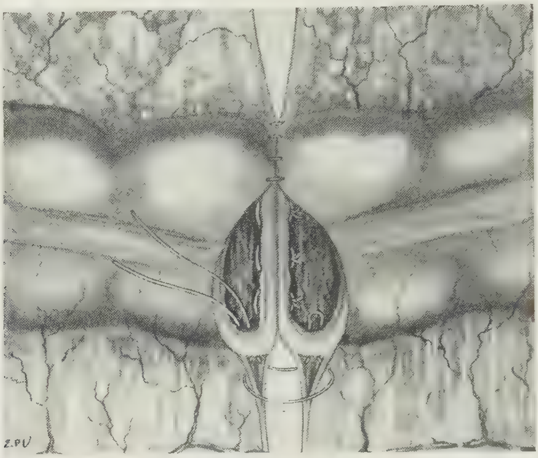


Fig. 3915.—End-to-end Entero-anastomosis of the Large Intestine (Transverse Colon) by the Connell Suture; _ The leaves of the mesentery are being approximated to each other, and to the barrels of their own intestinal segments, by means of Lee's mesenteric suture.

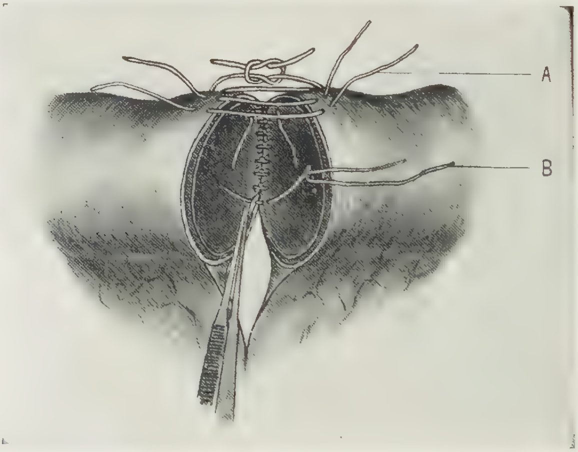


Fig. 3916.—Entero-enterostomy by the Czerny-Lembert Interrupted Suture: _ B, Czerny interrupted suture passing through mucous and part of submucous coats _ applied from within; A, Lembert interrupted suture passing through serous, muscular, and part of submucous coats _ applied from without.

The opening represented by the last suture can, however, be more simply closed by a seromuscular mattress-suture, as suggested by Gould (Fig. 3914).

Comments.—Instead of using traction sutures, thirds of the bowel margins can be held parallel by means of tenaculum-forceps, for easier suturing.

The application of the Connell technic to entero-anastomosis of the large bowel is seen in the junction of the ends of the transverse colon in Fig. 3915. In this pictures is also illustrated the method of introducing the penetrating mattress-suture from within the lumen of the intestinal ends _ by means of a curved needle held in a holder, in the right hand, aided by forceps, in the left, with which the margins are steadied during the passage of the needle. The intestinal ends are here held in relationship by means of two intestinal clamps. No great difficulty is experienced in suturing the first or posterior half of the circumference by this method _ but the difficulty in the second or anterior half is increased as the remaining opening through which one manipulates grows less.

End-to-end entero-enterostomy by the Czerny-Lembert interrupted sutures was at one time frequently employed _ and may have been the basis of the Connell technic. The margins of the mucous coats of the two ends of the intestine are brought together by the interrupted Czerny suture, which passes through this coat and part of the submucous coat, and is applied from within the lumen (Fig. 3916). The last mucous suture, or two, will be knotted on the outer side, but become buried. This is then followed by interrupted Lembert sutures carried through the serosa, muscularis, and part of the submucosa. and placed from without.

ENTERO-ENTEROSTOMY BY MAUNSELL'S INVAGINATION METHOD

Description.—In intestinal joinings made by this special method of simple suturing, a temporary window is cut in some part of the intestinal canal, near one of the two sites to be anastomosed (always in the larger piece of bowel) _ and through this opening the two ends, or two aspects of the intestine, are temporarily invaginated by means of traction sutures. The free edges of the two parts of the bowel, brought concentrically through the window, are now united by interrupted through-and-through silk sutures _ after which the site of anastomosis is drawn back into its normal position _ and the window is closed by interrupted silk Lembert sutures _ thus completing the operation.

Maunsell's method of entero-anastomosis is unusually well adapted to end-to-end unions of pieces of intestine, whether of the same size or of different sizes _ and may also be employed for lateral entero-anastomosis, either following excision of a piece of bowel or where no excision has been performed _ and even in cases of end-to-side implantation. It was at one time probably the most generally employed method for performing entero-enterostomy _ and remains, today, one of the simplest and safest methods for end-to-end union. Its description has recently been omitted from many surgical works _ as having been superseded by the more modern methods already described _ but owing to its worth, simplicity, and unusual range of adaptability, the various applications of the technic will be described here.

Operation.—Because of the various uses to which this method of entero-anastomosis may be applied, the technic in conjunction with its main fields of usefulness will be given.

(*a*) **End-to-end Entero-anastomosis of Segments of the Same Size** (Following Enterotomy or Partial Enterectomy).—Having brought the loop of intestine into the field, incise the intestine transversely (in the rare cases where this is indicated) _ or excise the indicated portion, together with the corresponding V-shaped part of the mesentery _ and bring together the edges of the mesentery with gut sutures. Two horse-hair sutures (or silk) are now introduced, which are temporarily left long and serve, primarily, as traction sutures _ after which they are cut short and serve as two of the permanent sutures. The first is placed at the antimesenteric aspect _ the needle being made to penetrate all the coats of the proximal intestine, near its free border, from within outward _ then all the coats of the distal segment of gut at a corresponding point, but now from without inward. (See Fig. 3917.) This suture is then knotted upon the inner side, one thread being cut short, the other left temporarily long as a traction suture. The second suture, somewhat more complicated, is placed at the mesenteric aspect _ beginning with that segment of gut of larger caliber (which becomes the intussuscipiens), the needle passes from within the lumen of intestine outward, penetrating the intestine near its free border and entering the triangular space where the two laminæ of the mesentery separate to embrace the barrel of the intestine _ then going through the corresponding lamina of that side of the intestine, is carried across to the opposite segment of gut (which is to become the intussusceptum), there penetrating, from without inward, the lamina of the mesentery of the same side _ and, passing onward, pierces the corresponding wall of intestine, emerging upon its inner aspect _ crosses thence to the opposite side of the same segment of gut _ pierces its wall from within outward, passing through the corresponding lamina of mesentery of that side _ thence across to the opposite segment of gut _ where it pierces, from without inward, the lamina of the mesentery of the same side _ passing thence onward and emerging in the lumen of that segment of gut at which the suture was started. This important suture is now drawn tight, thus approximating, by the peculiar manner of its passage, the laminæ of the mesentery closely to the barrel of the two segments of intestine at their most unprotected sites. Its knot having been tied on the inner side, one thread is cut short and one left temporarily long as a traction suture.

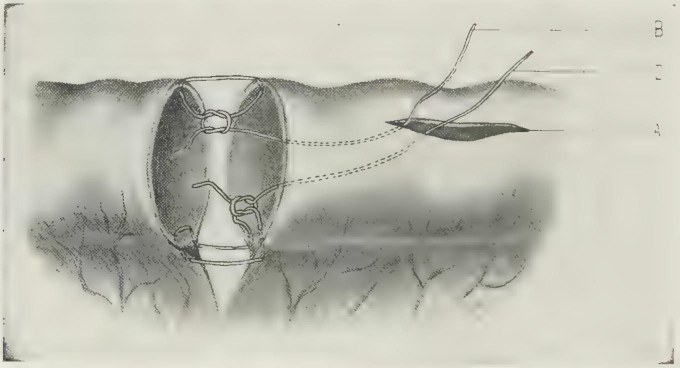


Fig. 3917.—End-to-end Entero-anastomosis of Segments of the Same Size (Maunsell) _ I; _ Placing sutures preparatory to invagination: A, Window in antimesenteric aspect of intussuscipiens; B, manner of placing the antimesenteric traction suture; C. manner of placing the mesenteric traction suture.

A temporary window is now made in the segment of intestine of larger caliber, independently of its being proximal or distal. If both pieces are of the same size, the window is generally made in the proximal portion. The opening is made upon the antimesenteric aspect of the intestine, in the form of a longitudinal slit of about 4 cm. (1½ inches) in length, beginning about 2.5 cm. (1 inch) from the divided end of the gut and extending in the opposite direction. This slit is often made by pinching up a fold of intestine longitudinally, between the left thumb and index, passing a knife through it and cutting upward _ but as this is very uncertain and inaccurate, it is best to have an Assistant so hold the intestine as to separate its walls and then make the slit by a controlled stab-like incision with a sharp, narrow bistoury, increasing its dimensions with the same instrument or with a pair of scissors _ or, even better still, carefully catch the antimesenteric aspect of the intestine with two forceps, about 1.3 cm. ($\frac{1}{2}$ inch) apart, raising a transverse ridge, which is cut with scissors in the long axis of the bowel, after which one blade of the scissors is introduced and the opening enlarged. A pair of forceps is introduced through the window and grasps first one and then the other of the traction sutures, drawing them out through the opening. While the intestines are steadied in the left hand, the traction sutures are drawn upon until the free end of the segment of gut further from the window is drawn into the lumen of the gut containing the window _ the free edge of the latter being turned inward and invaginated by the opposite segment as it enters _ the process of invagination continuing until the free ends of both emerge at the window as two concentric circles, which are drawn sufficiently far out through the window for subsequent manipulations. Both peritoneal surfaces will thus be in contact. (See Fig. 3918.) While the ends of the intestines are held upward and away from the opening by the traction sutures in the hands of an Assistant, a long needle threaded with horsehair (or silk) is passed straight across the concentric circles about midway between the two traction sutures, passing through all the coats of the four thicknesses of intestines at about 5 mm. (3/16 inch) from the free borders. After the passage of the needle, leaving a long piece of suture at either side, the suture is caught with forceps at the center of the opening of the concentric guts and drawn upward and outward a short distance and cut. Each suture is then tied over the free borders of the two thicknesses of gut embraced by it. Thus about twenty (or more if needed) sutures are placed at equidistant sites by the passage of ten lengths of horsehair (or silk) _ and are tied and cut. The

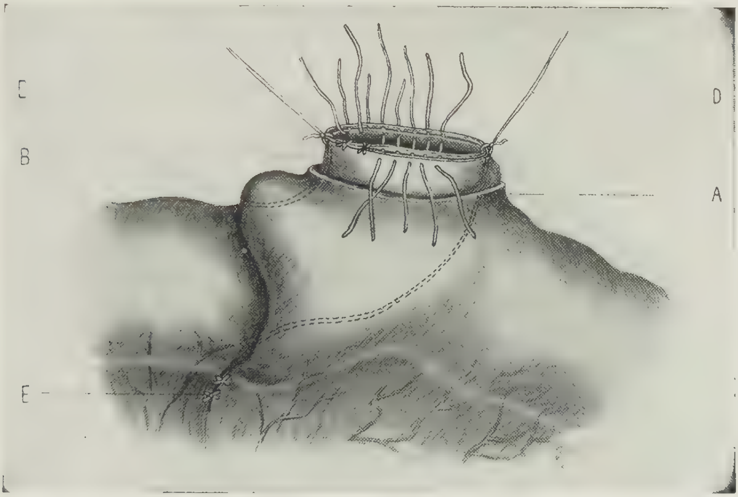


Fig. 3918.—The Same _ II; _ The invagination accomplished: _ A, Window in intussuscipiens; B, concentric ends of two pieces of intestine of equal size; C, antimesenteric traction suture; D, mesenteric traction suture; E, edges of mesentery sutured.

two long ends of the traction sutures are now cut short. (If they have been placed at inconvenient sites, in relation with the other sutures, they may be cut out and removed.) By gentle traction in the reverse direction the invagination is reduced _ the intestines now forming one continuous length. The window is then closed by continuous (or interrupted) Lembert sutures (see Fig. 3919), thus completing the operation.

Comment.—The above method is an imitation of nature's successful manner of performing enterorrhaphy, namely, by invagination and sloughing.

Maunsell used horsehair _ others have used silk and silkworm-gut.

By suturing the edges of the excised mesentery before rather than after uniting the intestines there is less danger of further separating the laminæ of the mesentery.

At the end of the operation the serous surfaces should be in contact _ and all of the knots at the end of the intestines should be within the gut. In thin-walled guts there is a tendency for the knots and threads not to be so well buried as in the thicker walls.

The sutures may be passed through the walls of the concentric guts in the ordinary manner and tied one by one, instead of in the above manner.

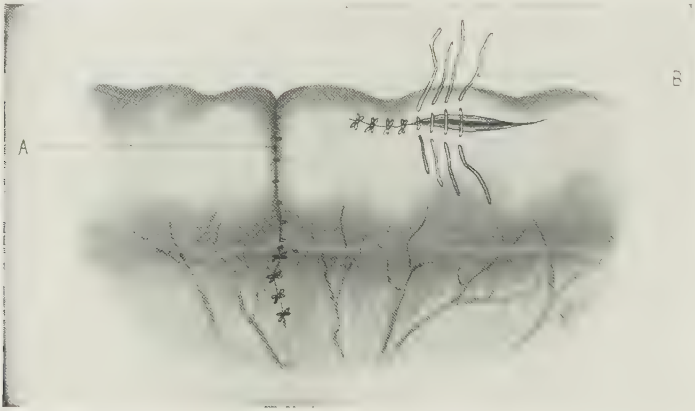


Fig. 3919.—The Same _ III; _ The Invagination Reduced: _ A. External view of suture line; B. closing the window with interrupted Lemberts.

The sutures should not be tied too tightly

This is an instance of using a single layer of through-and-through sutures in intestinal work _ but practical experience has proved the method a good one. To avoid the possibility of drainage-infection of the peritoneum by the sutures which pass through all the coats, some Surgeons place additional interrupted Lembert sutures outside of the regular row. Fine gut may be thus used.

(*b*) **End-to-end Entero-anastomosis of Segments of Unequal Size** (Following Partial Enterectomy).—The traction suture through the mesenteric borders is introduced in the above manner. A second traction suture is introduced in precisely the same manner as the antimesenteric traction suture above, but so placed as to pass through the edge of the upper part of the smaller gut and through the edge of the larger gut on its side, at a distance from its mesenteric attachment about equal to the diameter of the smaller gut. A third traction suture is passed through the antimesenteric border of the larger gut alone (see Fig. 3920). The window is now made in the larger gut _ and the invagination accomplished as in the above case. The two free ends of the gut will not now be concentric, as in the above instance, owing to the difference in size and to the fact that the circumference of the smaller gut is fixed to the circumference of the larger in two places by suture.

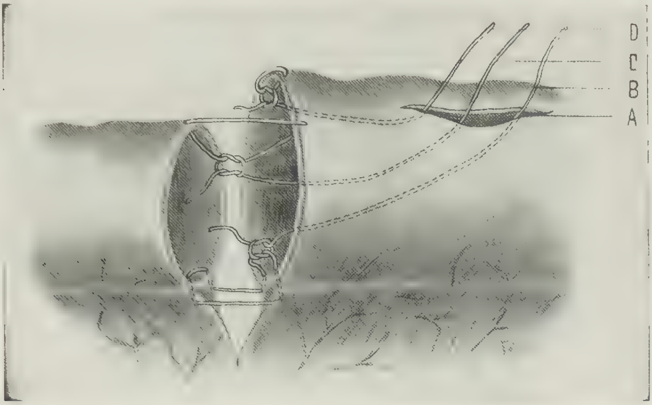


Fig. 3920.—End-to-end Entero-anastomosis of Segments of Unequal Size (Maunsell) _ I; _ Preparatory to Invagination: _ A, Window in intussuscipiens; B, mesenteric traction suture; C, traction suture which is antimesenteric for the smaller and lateral for the larger gut; D, traction suture which is antimesenteric for the larger gut.

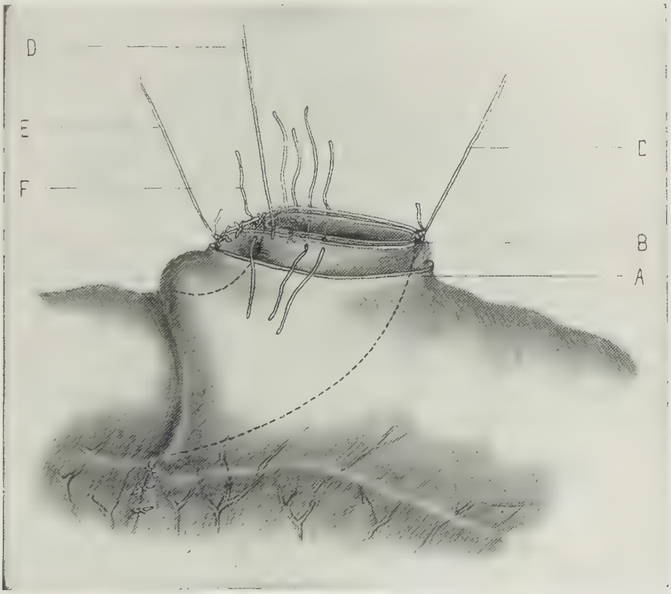


Fig. 3921.—The Same _ II; _ The invagination accomplished· _ A, Window in intussuscipiens; B, non-concenteric ends of two pieces of intestine of unequal size; C, mesenteric traction suture; D, traction suture which is antimesenteric for the small and lateral for the large gut; E, traction suture which is antimesenteric for the large gut; F, one of the sutures uniting the opposite edges of the redundant portion of the large gut.

The suturing of the borders of these two non-concentric circles can be best accomplished by the passage of a needle through only the two walls in contact at a time _ instead of simultaneously through these two and the opposite two, as in suturing coils of similar caliber. Each suture is at once tied. The first and second traction sutures become permanent – the third (through the larger gut alone) is removed. It is well to put the sutures in alternately on the two sides, proceeding from the mesenteric toward the antimesenteric border, until the edges of the small intestine have been sutured to those of the larger. When near the antimesenteric aspect of the smaller gut the redundancy of the larger gut will be apparent. This redundancy, if at all marked, is best disposed of by cutting, with scissors, a V-shaped piece out of the antimesenteric aspect of the larger gut, of a size calculated for the individual case. This V is now carefully sutured by approximation of its margins by an overhand stitch, from its apex toward the antimesenteric aspect of the smaller gut, being especially careful to approximate the edges of the larger intestine, at the base of the V, with the edges of the antimesenteric border of the smaller gut. (See Fig. 3921.) The invagination is reduced by gently drawing upon the intestines – and the window is closed as in the regular operation. While an elbow, marking the excess of the larger over the smaller intestine, will be present, the union will be secure. (See Fig. 3922.)

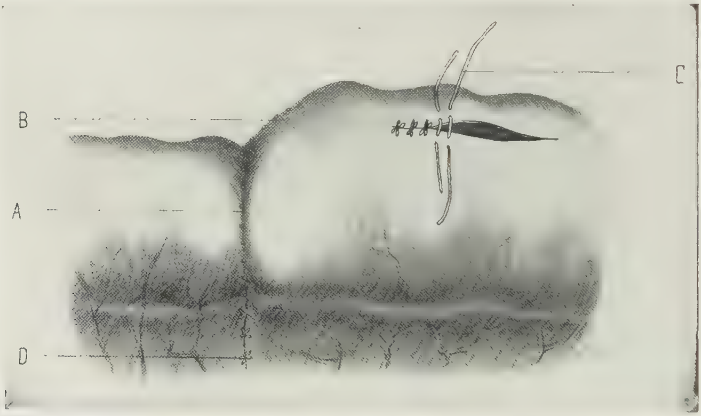


Fig. 3922.—The Same – III; – The invagination reduced: A, External view of portion of suture line representing the end of the small intestine; B, external view of portion of suture line represented by the redundancy of the large intestine; C, closing the window with interrupted Lemberts; D, interrupted sutures approximating the edges of the cut mesentery.

(*c*) **Lateral Entero-anastomosis Following Partial Enterectomy.**—Partial excision of the intestine and of the corresponding mesentery is done, the clamps having been placed especially well away from the site of operation. The two ends of intestine are overlapped upon their free, antimesenteric borders, and a continuous Lembert suture (leaving the end of beginning long, after knotting) is run along what will be the posterior aspect of the junction, extending at either end slightly beyond the line of future union around the common opening – and left long and threaded. (See Fig. 3923.) Two corresponding incisions in the long axis of both guts are made. The posterior edges of the wounds are sutured together by an overhand, continuous suture of all the coats, leaving the end of beginning long, after knotting, and also the end of ending long and threaded. Forceps are protruded through the opening and out either free end of the intestine, catching up the free end in their grasp and drawing (invaginating) it into the lumen and through the opening. A circular silk ligature is then tied around either free end and they are dropped into their respective lumina. The needle attached to

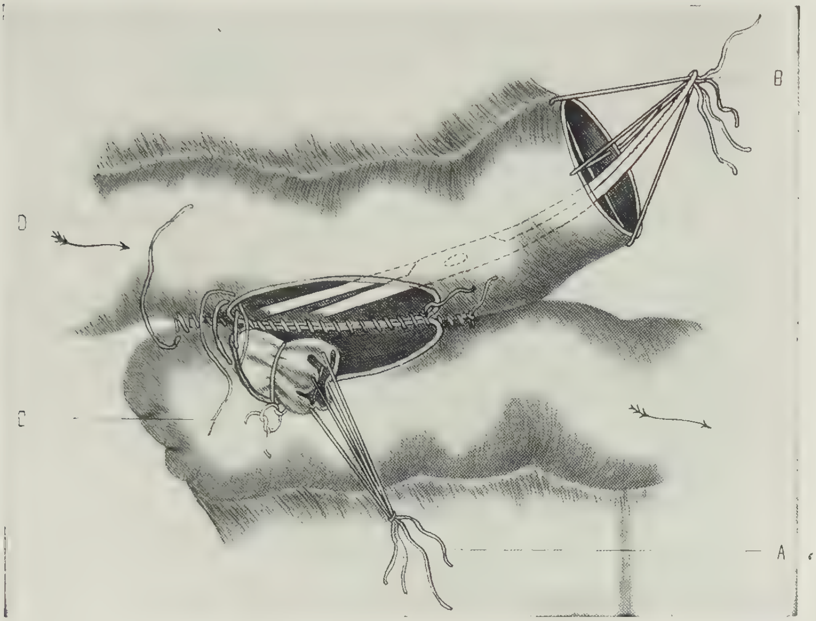
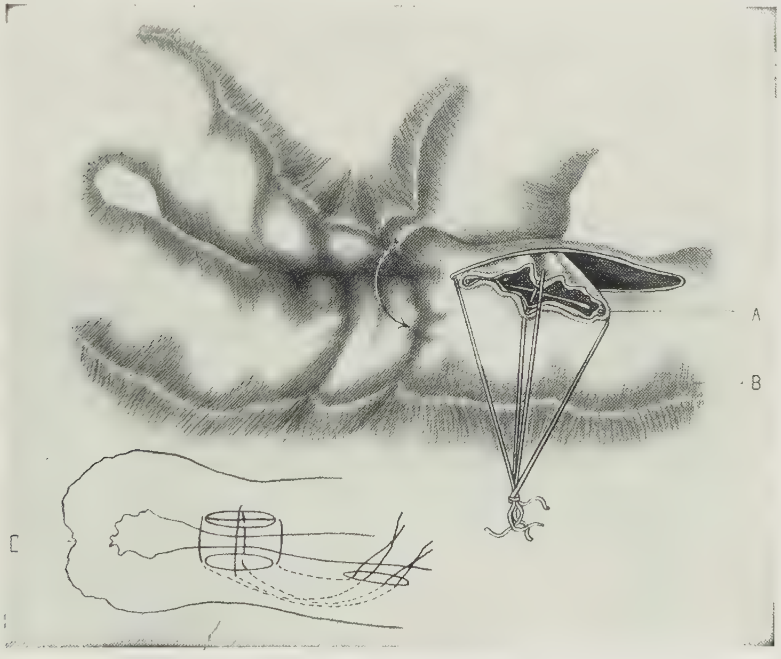


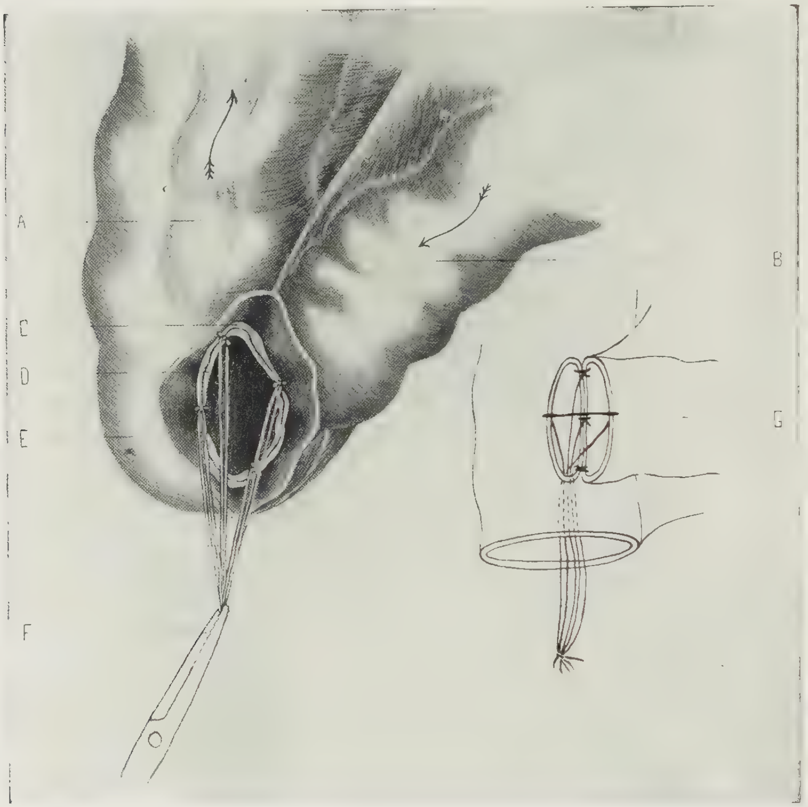
Fig. 3923.—Lateral Entero-anastomosis Following Partial Enterectomy (Maunsell): A, End of intestine invaginated through window and circular ligature placed around it; B, traction ligatures grasped by forceps in act of invaginating opposite end of intestine; C, continuous overhand suture of all coats; D, continuous Lembert suture of outer coats.



Figs. 3924 and 3925.—Lateral Entero-anastomosis Without Preceding Partial Enterectomy (Maunsell): A, Intussusceptum drawn through window; B, intussuscipiens, with window in its antimesenteric aspect; C, diagram showing manner of placing traction sutures.

one end of the "whipping over" suture then continues the process until the corresponding edges of the entire circumference are brought together and the long ends tied. Then the needle upon the serous suture is taken up and the continuous Lemberts through the serous and muscular coats are continued around the anterior aspect of the wound, burying-in the first layer. The edges of the mesentery are sutured as indicated.

The circularly ligated ends of intestine are reinforced with interrupted or continuous Lemberts.



Figs. 3926 and 3927.—Entero-anastomosis by End-in-side Implantation (Maunsell): _ A, Colon; B, ileum; C, free edge of lateral window in colon; D, free edge of end of ileum; E, free open end of colon; F, traction sutures invaginating free end of ileum and lateral opening of colon through open end of colon G diagram showing manner of placing traction sutures.

(*d*) **Lateral Entero-anastomosis Without Preceding Partial Enterectomy.**—Two loops of intestine are approximated along their antimesenteric borders _ two corresponding axial incisions are made _ a window is then cut about 2.5 cm. (1 inch) above _ four traction sutures are applied to the cut margins and knotted within _ a pair of forceps, passed through the window, catches the four traction sutures and draws them back through the opening _ by means of these traction sutures the lateral aspects of the two pieces of intestine are invaginated through the window _ sutures are applied to their margins, as in the end-to-end approximation _ the invagination is reduced _ and the window closed by interrupted or continuous Lembert sutures. The line of anastomosis may be reinforced by Lemberts if considered necessary. (See Figs. 3924 and 3925.)

(*e*) **Entero-anastomosis by End-in-side Implantation.**—Excise the indicated portion of intestine with its corresponding part of mesentery _ bring the free end of the smaller bowel to the antimesenteric aspect of the larger gut, near its end _ about 2.5 cm. (1 inch) from the free margin of the latter, upon its antimesenteric aspect, make an axial incision, corresponding in length to the diameter of the free end to be implanted _ place four traction sutures, knotting them within _ draw these traction sutures out through the free end of the gut in which the lateral opening was made by means of forceps _ suture together the margins of the free end and the lateral opening of the larger gut, as in end-to-end approximation _ reduce the invagination _ close the free end of the gut with the lateral opening first by continuous, overhand silk sutures, which are then buried by interrupted gut sutures of the Lembert type _ thus completing the operation. The edges of the mesentery are so sutured as to close all openings. The site of implantation may be reinforced by Lembert suturing if considered necessary. (See Figs. 3926 and 3927.)

Note.—In all the operations by the Maunsell method the traction sutures may be dispensed with _ the invagination being accomplished by clamp-forceps introduced through the windows, as in Ullmann's modification of Maunsell's operation (p. 726).

(B) ENTERO-ENTEROSTOMY BY MEANS OF ABSORBABLE MECHANICAL DEVICES LEFT WITHIN THE INTESTINE

IN GENERAL

Description.—The mechanical devices, which are made of some absorbable material and are inserted into the intestinal tract to serve as distending frameworks over which the suturing may be conveniently applied, are bobbins, buttons, cylinders, plates, etc. They are left within the lumen of the intestinal tract, either to be entirely absorbed, or to be partially absorbed and the residue passed by nature. While possessing, in common with non-absorbable devices the property of aiding in the approximation of the parts, they possess the additional advantage of becoming absorbed after having accomplished their purpose _ with the concomitant disadvantage of possibly sometimes becoming absorbed before having done their work completely.

The bobbins are in the form of two cones united at their apices, which is their smallest part. Their shape has a greater tendency to approximate the intestinal surfaces than has the button or reel. The buttons are very much like ordinary buttons, or possibly more like reels. The size of the barrel is everywhere equal between the flanges. Various forms of plates have been used, of which the best known were probably Senn's bone-plates. Some forms of cylinders were used. The terms designating these devices are sometimes used interchangeably. These devices are made of various materials _ the most usual being decalcified bone, or some form of vegetable (such as potato, carrot, turnip, etc.). In some the bulk of the device was made of entirely absorbable material, and a small part of the center, where the pressure is borne, was made of more imperfectly absorbable or of non-absorbable material. These devices were always used in connection with some form of suturing _ never alone. As to their range of applicability _ their chief field of usefulness was in end-to-end approximation _ and only to a limited extent in lateral entero-anastomosis, end-in-side implantation, gastro-enterostomy, and cholecystenterostomy.

These absorbable devices are now largely replaced by methods of simple suturing.

END-TO-END ENTERO-ENTEROSTOMY BY MEANS OF ABSORBABLE BOBBINS

Description.—The Allingham partially decalcified bone bobbin will be taken as representing this type, the steps of the operations being the same whether the bobbin be of this or vegetable material. In Allingham's bobbin the bone is decalcified to within 3 mm. (3/16 inch) of its very center, which is left firm to resist pressure made by the suture. The two portions of the intestinal tract are approximated over the center of the bobbin by running sutures inserted, in purse-string fashion, in the free end of each piece of intestine.

Operation.—Having completed the steps of a preliminary enterectomy, place a running, overhand purse-string suture of silk in the ends of each piece of intestine, passing through all their coats, the thread entering and coming out at the antimesenteric borders, leaving both free ends long. (See Fig. 3928.) While less simple, a more satisfactory form of purse-string suture (owing to the manner in which it approximates the laminæ of the mesentery) is the one used in connection with the operation of entero-enterostomy by means of the Murphy button (p. 729), and this suture is equally applicable here. Insert one end of the bobbin into the proximal, or distal, end of the intestine, and, having made the double turn of the friction-knot, draw the purse-string rather tightly down upon the intestine over the center of the bobbin, but do not tie the final knot. Insert the opposite end of the bobbin into the end of the opposite piece of intestine and similarly tie it.

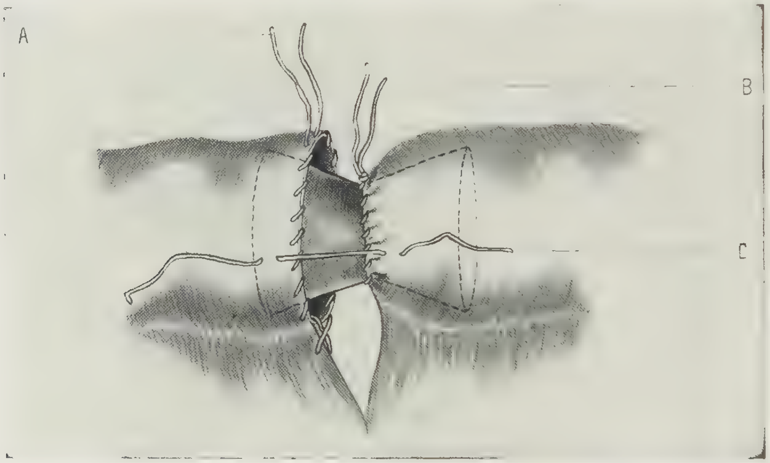


Fig. 3928.—End-to-end Intestinal Approximation by an Absorbable Bobbin; Position of bobbin is shown partly in outline: A, Purse-string suture in position ready to be tightened; B, purse-string suture tightened and tied; C, interrupted Lembert suture in position to be tied.

When both segments of intestine are molded well into position, so that the serous surfaces are well approximated, each suture is tightened with moderate firmness and the final knot in each tied, thus securely bringing and fastening the ends of the intestines at the center of the bobbin, and holding in contact rather extensive serous surfaces for union. The serous surfaces may be scarified with a needle for about 1 cm. ($\frac{3}{8}$ inch) around the line of suture, to cause exudation of lymph and firmer union. A few interrupted Lemberts of fine gut may be applied around the line of union, further approximating the serous surfaces, if thought necessary. The mesentery is treated as in other operations of entero-enterostomy.

END-TO-END ENTERO-ENTEROSTOMY BY MEANS OF ABSORBABLE BUTTONS

Description.—The Landerer potato button will be taken as representative of this type of mechanical device. A purse-string suture is inserted into each end of the intestinal opening ; these are tightened over the barrel of the button, or reel, thus relatively approximating the ends of the intestine. But as the barrel of the button or reel is of the same dimension for some distance, there is not the same tendency for the approximated ends of the intestine to be held in close contact as is the case in the bobbin, where there is the narrowest part of the barrel at the center, into which the segments may be readily tied. An overlying line of interrupted or continuous Lembert sutures is, therefore, placed over the ends approximated by the purse-strings ; and thus securely apposes serous surfaces.

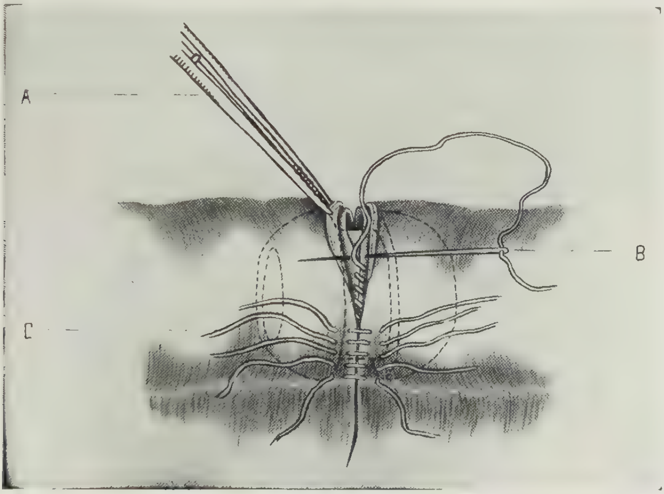


Fig 3929.—End-to-end Intestinal Approximation by an Absorbable Button; Position of button is shown in outline: A, Forceps everting lips of intestine to aid suturing; B, continuous suture of all coats; C, interrupted Lembert sutures of serous and muscular coats.

Operation.—Having completed the steps of a preliminary enterectomy, a purse-string suture of silk or of chromic gut is inserted into the end of each piece of intestine ; in the same manner, preferably, as in Murphy's button operation (p. 729). Each end of the intestine is drawn over the flange of the button on to the barrel ; the purse-string is then moderately tightened and cut short, thus bringing the two ends of the intestine into contact. (The narrower the barrel of the button, the closer will be the contact at this stage.) The circumferential margins of the intestines are united with a line of interrupted or continuous Lembert sutures of the serous and muscular coats. The mesentery is repaired as in other operations of entero-enterostomy. The technic is shown in Fig. 3929 (in which the mucosa is shown separately sutured).

END-TO-END ENTERO-ENTEROSTOMY BY MEANS OF ULLMANN'S MODIFICATION OF MAUNSELL'S OPERATION

Description.—Up to the application of the Ullmann modification, which is applied after the invagination of the ends of the intestines through the window in one of the pieces of gut, the steps of the operation are identical with those described under the Maunsell method (p. 715). The two ends of intestine having been brought through the window, a carrot (or other vegetable, or decalcified bone) bobbin is inserted within their concentric lumina, so that its groove is grasped by their walls, which are then tied over the groove in a circular manner, with gut or silk. The invagination is then reduced _ and the longitudinal wound, forming the window, closed.

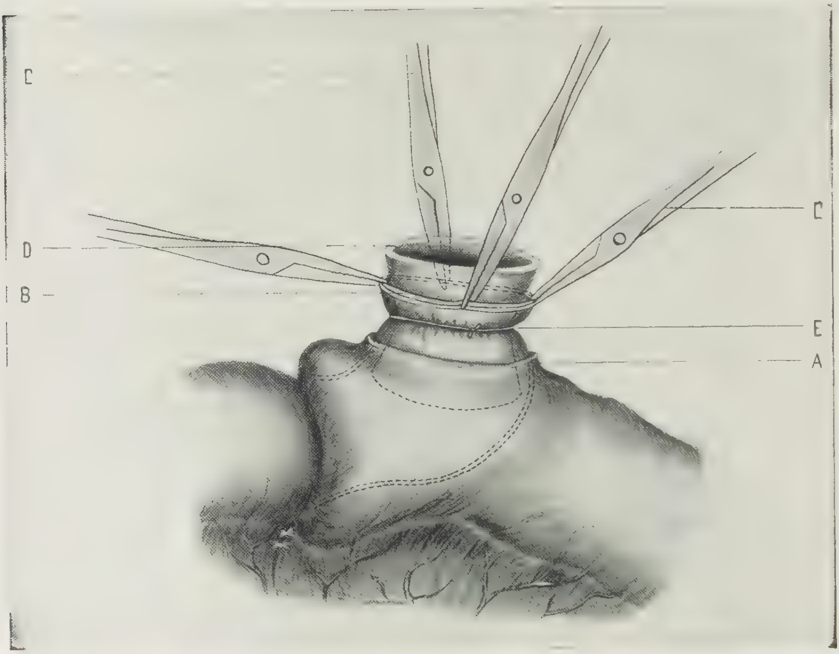


Fig. 3930.—Entero-enterostomy by Ullmann's Modification of Maunsell's Invagination Method: _ A, Window in intussuscipiens; B, concentric ends of intestines drawn through window; C, C, traction forceps drawing ends of intestines through window; D, absorbable bobbin within concentric ends of intestines; E, ligature binding ends of both pieces of intestine to groove of bobbin.

Operation.—The operation, up to the point of invagination, is precisely the same as in Maunsell's operation (p. 715). The invagination is now accomplished by passing two catch-forceps through the window _ one catching the mesenteric and the other the antimesenteric aspects of the end of the proximal gut (the gut in which the window usually is) _ and draws these out simultaneously through the window. The mesenteric and antimesenteric aspects of the edges of the distal gut are similarly caught by two catch-forceps introduced through the window _ which are also drawn out simultaneously through the opening. These last two forceps are removed from the distal gut and made to grasp the edges of both guts at their sides. The first two are then also removed from the first gut and made to grasp the edges of both guts at the same site each was grasped by a single forceps. Thus the concentric ends of the two intestines are readily held open by the four pairs of forceps equidistantly placed. These forceps are given to an Assistant, who holds them with one hand, while holding the bobbin with the other. (See Fig. 3930.) The bobbin is now introduced into the concentric openings of the intestines _ the walls of the two guts are then tied down into the groove of the bobbin with thick catgut or silk (which will not likely cut through). The forceps are relaxed _ the invaginated intestines are reduced _ the window is closed by interrupted or continuous Lembert sutures _ the mesentery is repaired _ and the operation concluded. (See Fig. 3931.)

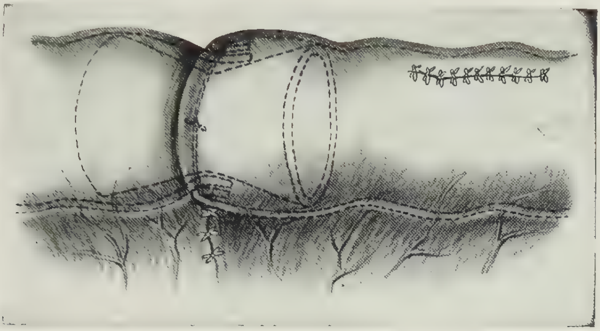


Fig. 3931.—Entero-enterostomy by Ullmann's Modification of Maunsell's Invagination Method: _ Showing the reduction of the invagination and closure of the window _ bobbin and ends of intestine being shown in outline.

END-TO-END ENTERO-ENTEROSTOMY BY COFFEY'S METHOD

Description.—The free ends of intestine, after having been first united at their mesenteric aspects by two or three Connell sutures, are drawn over a vegetable tube (made of potato, carrot or turnip, preferably the first) and made to meet and overlap at its center by means of two long needles passed through tube and intestines transversely, at right angles to each other _ after which any form of suture desired is applied _ the pins then withdrawn _ and the potato-tube pushed on down and crushed.

Operation.—Having completed, one may suppose, the steps of an excision of a portion of the intestines, the free ends are brought into contact and, while thus held by an Assistant, three Connell sutures placed at the mesenteric aspect, the central one embracing both laminæ of the mesentery of both ends of the intestine _ each suture passing from within the lumen of one end outward through its own wall, and from without inward through the corresponding site of the opposite end _ then from within outward from the lumen of the opposite end, and from without inward through the corresponding site of the original end, back into the lumen of the original end _ where the free ends of the suture are tied within the first piece of intestine. (Fig. 3932). One end of the united pieces of intestine is then drawn over the potato-tube up to the center of the tube _ and is held there until the opposite end of the intestine is similarly drawn over the opposite end of the tube to meet it, and also held in position. Two long needles (or hat-pins, knitting-needles, probes, or toothpicks) are now passed transversely through the potato-tube and through the ends of the intestine, at right angles to each other _ one entering near the mesenteric, and one at the midlateral aspect. As these needles enter and emerge, they are made to pierce the overlapped edges of intestine _ and thus hold them in four places _ overlapped where

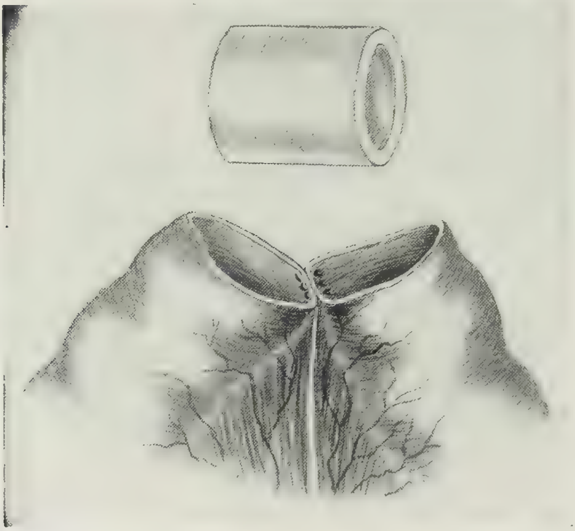


Fig. 3932.—END-TO-END ENTERO-ENTEROSTOMY BY COFFEY'S METHOD – I; Ends of intestine brought together and their mesenteric aspect united by three Connell sutures – preparatory to inserting hollow potato-tube shown above.

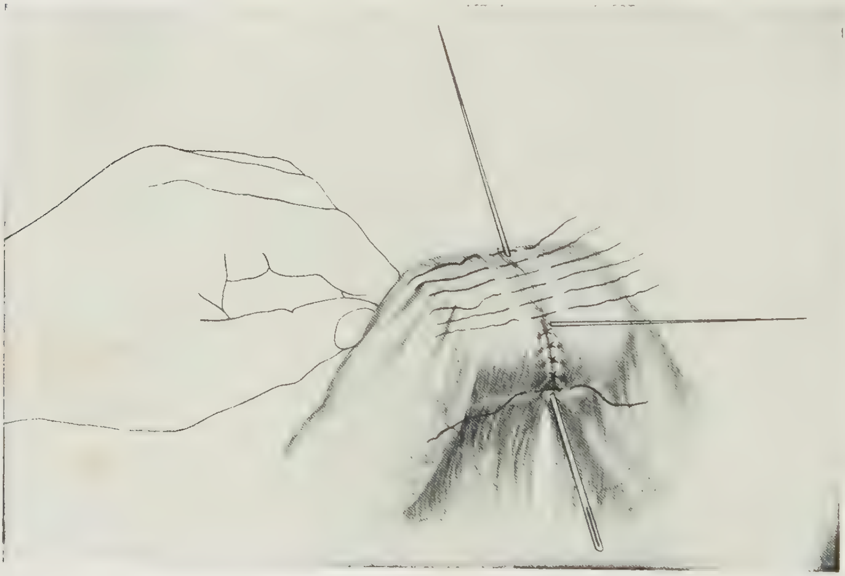


Fig. 3933.—END-TO-END ENTERO-ENTEROSTOMY BY COFFEY'S METHOD – II; – Two ends of intestine drawn over tube and held in relation with each other by long needles thrust through the potato-tube at right angles to each other and piercing the overlapped edges of intestine. While thus held interrupted Lembert (or other) sutures are applied – after which needles are withdrawn – and potato-tube may be crushed

the needles penetrate, and overlapped or in comparatively close contact throughout the rest of the quadrants (Fig. 3933). While the ends of intestine are thus held, any form of suture desired may be placed – interrupted Lemberts _ continuous Lembert _ the Halsted quilt suture _ or a double line of sutures. Having completed the suturing, the pins are withdrawn. In the case of interrupted sutures, those stitches which were placed while the needles were *in situ* can now be more satisfactorily drawn together after the removal of the needles. The potato-tube is carefully pressed away from the site of operation, distally to it _ and is then crushed into comparatively small pieces. The abdomen is closed in the usual manner.

(C) ENTERO-ENTEROSTOMY BY MEANS OF NON-ABSORBABLE MECHANICAL DEVICES LEFT WITHIN THE INTESTINAL CANAL

IN GENERAL

Description.—These devices, usually made of metal, serve, as in the case of absorbable devices, as frameworks over which the intestinal joinings are made _ but are left within the intestinal tract to be passed out at the anus by the efforts of nature. The Murphy button may be taken as the most generally used representative of this class.

ENTERO-ENTEROSTOMY BY MEANS OF THE MURPHY BUTTON

Description.—The junction between the intestinal coils is accomplished by inserting one-half of an ingenious button into the free end of each portion of intestine _ these half-buttons are held in place by specially applied sutures _ and the two halves of the button are then approximated. The opposite surfaces of the two cups of the button, aided by a spring in one of the cups, keep up a constant pressure upon the opposed surfaces of intestine, thus holding their approximated serous surfaces in contact. Union takes place between the surfaces thus held together, especially along their circumferential aspects _ while the buttons are freed by pressure necrosis and are passed by bowel.

End-to-end Entero-anastomosis.—Having opened the abdominal cavity, complete the partial enterectomy in the usual manner. Preparatory to the insertion of half of the button into each free end of the gut a silk suture is applied in a special manner. (See Fig. 3938.) A long, straight needle is threaded upon a piece of silk about 30 cm. (12 inches) long _ this suture begins just to the right of the center of the antimesenteric border, entering about 3 mm. ($\frac{1}{8}$ inch) below the free edge, and passing from without directly inward _ thence, following the right-hand margin, in an overhand stitch, over (not through) the border of the intestine to the outer side _ thence through the wall from without inward _ and so on, until the lamina of the mesentery belonging to that side is reached. As the suture passes from within the lumen, over the wall outward for the last time on that side, it also passes obliquely over the lamina of the mesentery of the opposite side. The suture is then carried through both laminæ of the mesentery as a reversed stitch _ emerging at the outer aspect of the opposite lamina. It is now obliquely carried over the lamina of the original side (and across the first limb of the suture that was carried over the opposite lamina) into the lumen of the intestine, toward its opposite wall _ and passes through this wall of the intestine from within outward. The order is now reversed, and (to get out of the lumen on the left side) the thread is always carried through the free border of the intestine from within outward _ thence passes over (not through) the wall from without inward into the lumen _ and so on, until it enters the lumen for the last time, at the antimesenteric border _ here, at a distance of about 5 mm. (3/16 inch) from its point of entrance, and on the same level, the needle passes through the intestinal wall from within outward. Thus a "puckering" or "draw-string" is formed, so applied that when drawn about the button it will approximate the leaves of the mesentery closely about the ill-protected triangle at its base — and the two threads emerging side by side upon the outer aspect are ready to be tied about the button. Although these sutures pass through all the coats of the intestine, they are within the spring, or pressure-cup, of the button. Similar sutures are inserted into the free ends of the opposite piece of intestine. (See Fig. 3935.)

Each cup, or button, is now grasped by its stem (not, as so often shown in pictures, by the cup itself) by the tip of a pair of special or pointed forceps (forceps with rounded or squarish points would tend to bend the perfectly circular opening of the stems). Both are now ready for introduction. The male button (one with smaller stem) is always introduced into the end of the proximal gut (because when its stem has slipped into the stem of the female button, a slight elbow, or projection is formed where its free margin ends — which is harmless while in the direction of the intestinal current, but might cause obstruction by particles of solid food lodging against it, if in the opposite direction). This male half of the button is introduced into the proximal gut just far enough for the free end of the gut to come well around the stem. The suture is then drawn moderately tight and tied with a double knot (the first being a friction-knot) around the stem — evenly distributing the puckered gut with a probe as the thread is tightened. An Assistant takes the forceps and so holds them that the stem of the button does not slip within the intestine. The female button (one with larger stem) is similarly introduced into the distal end of the gut. The suture is similarly placed and

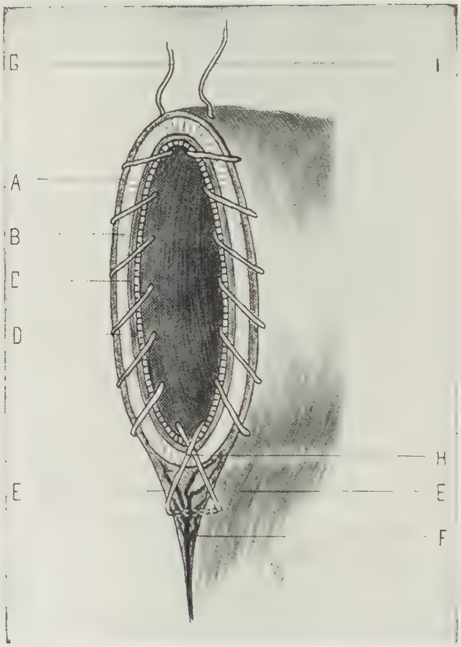


Fig. 3934.—Cross-section of Intestine Showing Manner of Placing the Purse-string Suture for Murphy's Button: — A, Serosa; B, muscularis; C, submucosa; D, musosa; E, E, laminæ of mesentery; F, mesenteric vessel and connective tissue; G, beginning of suture; H, crossing of suture, approximating aminæ to each other and to barrel of intestine; I, end of suture, ready to be knotted with opposite end.

tightened about it _ and the forceps given to an Assistant to hold in the same manner as with the male button.

The Assistant holding the buttons so crosses the hanples of the forceps as to present the buttons to the Surgeon in their right relation for immediate approximation. (See Fig. 3935.) The Surgeon now grasps a button in the thumb and first two fingers of each hand, with the hollows of the buttons looking toward each other. The Assistant then simultaneously releases the hold of the two forceps upon the stems of each half-button. At the moment of release the Surgeon guards the buttons lest they slip out of reach into the intestines (by pressing them against the binding sutures). The Surgeon now approximates the two half-buttons, one held in the fingers of each hand _ calculating, in their slow and deliberate approximation, that the intervening intestinal walls will be so disposed as to make an even layer over the cups of the buttons _ adjusting the deficiency or excess of the puckered intestine with a probe, as indicated _ and finally pressing the two halves home as far as his judgment deems necessary to secure good apposition without too great compression. (See Fig. 3936.) The edges of the mesentery are sutured and the intestine dropped back into the abdomen.

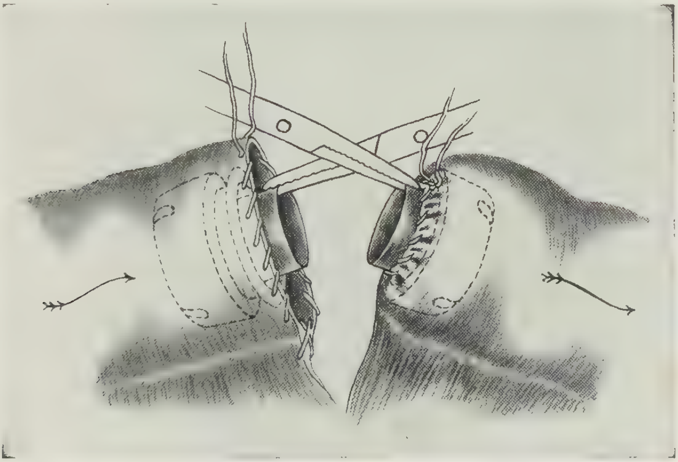


Fig. 3935.—End-to-end Intestinal Anastomosis by Murphy's Button; _ Showing manner of introducing button into lumen of intestine _ male button on left, with purse-string ready to be tightened; _ female button on right, with suture tightened.

Comment.—Segments of intestine of unequal size may be thus united by end-to-end anastomosis with the Murphy button _ care being exercised in tying the button into the end of the larger gut, and especially in the act of approximating the two buttons, to see that the puckered excess of the intestinal tissue, particularly in the case of the larger gut, is evenly distributed around the stem of the buttons _ and that when the halves of the buttons are finally pressed home the serous surfaces everywhere come together.

A line of interrupted or continuous Lemberts is used by some Surgeons to reinforce the margins where the buttons meet after their apposition. While not generally necessary, such a line of reinforcing sutures may be used where considered indicated, and is safer. (See Fig. 3936.)

See that the purse-string sutures are, after knotting, cut close, and that their ends are not held by the cups of the buttons _ thus retarding the escape of the button, and possibly serving as infecters of the peritoneal cavity.

All buttons used should be of a size that will not press upon the intestinal walls, else sloughing may occur.

Lateral Entero-anastomosis Following Partial Enterectomy.—Having excised the portion of intestine, the free ends of the two pieces of gut are first closed by overhand continuous suture of all the coats—followed by a second tier of interrupted or continuous Lemberts burying in the first row. Purse-string sutures are now placed. (See Fig. 3937.) These consist of silk and are carried by an extra long, straight needle (such as Keith's abdominal needle). The site for the insertion of the half-button into each segment of gut having been chosen, which will be upon the antimesenteric aspect of the guts, beginning about 2.5 or 5 cm. (1 or 2 inches) from their ends, it is necessary to calculate the length of the incision to be made, as its length will regulate the length and position of the purse-string suture. If the oblong button be used, the length of the incision will be a little less than the transverse diameter of the button,—and if the round button, a little less than the diameter—in order that when the button is insinuated through an opening requiring slight distention for its entrance, it will close about it sufficiently to slightly grasp it. The sutures should be put in so that their looped end is toward the free end of the gut. The suturing passes through all the coats. Conceiving an imaginary straight line, running longitudinally, upon the center of the antimesenteric aspect of the bowel to mark the site for the future incision for the reception of the button, the needle is made to enter the wall of the gut about 6 mm. ($\frac{1}{4}$ inch) above (or below, as the case may be) this imaginary line, and about 3 mm. ($\frac{1}{8}$ inch) to one side—passing through all the coats into the lumen—again passing outward (always traveling in a straight line parallel with and about 3 mm. [$\frac{1}{8}$ inch] from the imaginary line) and emerging about 6 mm. ($\frac{1}{4}$ inch) from the point of entrance—and so on, until it emerges finally about 6 mm. ($\frac{1}{4}$ inch) beyond the opposite end of the imaginary line—here the loop is formed, the needle crossing over and entering the intestinal wall at a point corresponding with its last emergence, but on the opposite side of the imaginary line—and travels down this side in the reverse direction, but in the same manner as on the opposite side—finally emerging at a point

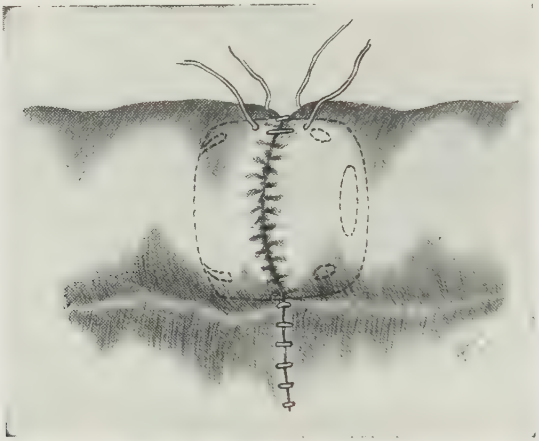


Fig. 3936.—END-TO-END INTESTINAL ANASTOMOSIS BY MURPHY'S BUTTON;—The half-buttons approximated and pressed home. Two loose, interrupted Lembert sutures are shown in the position which a tier of these sutures would occupy if used.

corresponding with the entrance on the original side. Both ends of the suture are left long and the loop loose.

An Assistant now so holds the bowel (which has been clamped at some distance from the free ends) as to separate its walls – while the Surgeon, by a quick, controlled stab of a narrow, sharp bistoury, incises the gut midway between the two parallel lines of the purse-string suture, and makes an opening a little less in length than the diameter of the button to go through it – and especially considerably less in length than the length of the surrounding purse-string. Care is taken that the mucous membrane is not simply pushed ahead of the knife, instead of being cut, and that the lumen is well opened up. The button, grasped by forceps, as in the ordinary end-to-end operation, is now insinuated into the opening, placing the male button in the proximal gut. The purse-string is drawn tightly enough to approximate the walls of the gut to the stem of the button and tied – evenly distributing the puckered intestine around the stem. The forceps holding the button is then given to an Assistant, who holds it as in the end-to-end operation. The opposite site of the intestine is similarly treated and the female button inserted. The Surgeon, grasping a button in the fingers of each hand, with their stems facing (as they have been directed by the crossing of the forceps), signals to the Assistant to release the buttons by relaxing the forceps – and then pushes home the two halves – using the same precautions as in the end-to-end approximation, for the even distribution of the intestinal walls. (See Fig. 3938.)

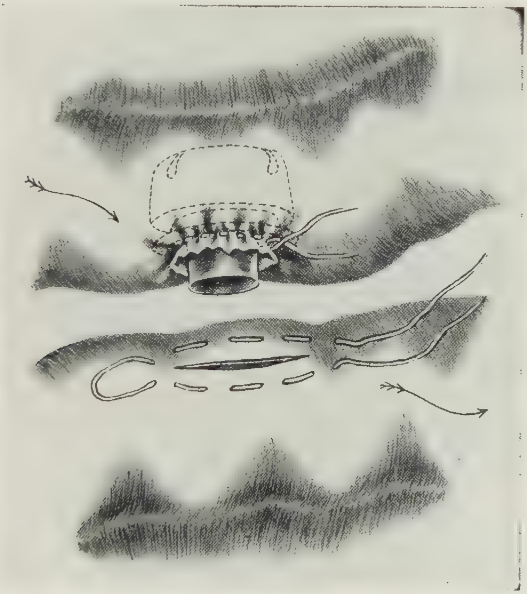


Fig. 3937.—Lateral Intestinal Anastomosis by the Murphy Button; – The manner of placing the purse-string suture is shown upon the lower intestine – and the male button introduced, with suture tightened, is seen within the upper intestine.

The management of the mesentery will here differ from its management in the end-to-end operation, as the continuity of the intestinal canal will not be continued in one straight line. It is better (unless otherwise indicated) not to excise a V-shaped portion of mesentery, but simply to fold over and suture in contact with each other, and with neighboring mesentery, the layers of the redundant fold of mesentery. If a V-shaped portion be excised, the two free borders of the mesentery left should be so sutured down to adjacent mesentery as to leave no openings for hernia.

Comment.—See the general comments under the end-to-end approximation.

Care should be used that in approximating the two sites of the intestines, the direction of the intestinal flow should be maintained.

The button used may be of the oblong type, which is better for this purpose – or of the ordinary round type.

The operation of lateral approximation after closure of the ends of the resected gut is but rarely indicated – the usual method of junction following excision being by end-to-end approximation.

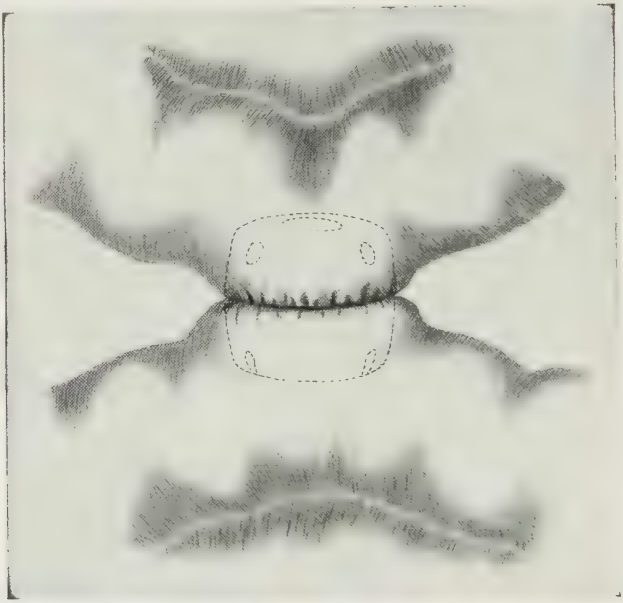


Fig. 3938.—Lateral Intestinal Anastomosis by the Murphy Button; – The two half-buttons are shown approximated. Interrupted or continuous Lembert sutures may reinforce the contiguous surfaces, if considered necessary.

Instead of using the purse-string suture to hold the button-halves in place, Carle approximates the borders of the intestinal opening by one or two interrupted Lembert sutures placed at either end of the incision, thus lessening its length and grasping the button. But the regular method is probably better.

Lateral Entero-anastomosis Without Partial Enterectomy.—In this operation the two buttons are inserted into the antimesenteric aspects of the two indicated coils of intestine – the method of insertion being identical with that just described. No excision of intestine takes place. The oblong button is to be preferred. Reinforcing Lemberts may be used.

Lateral Anastomosis With Weir's Modification of Murphy's Button, Introduced by Gallet's Method.—The male half of the original button is so modified, by being sharpened and beveled, that it can be made to penetrate the walls of the intestine. Both buttons are introduced, by means of special forceps, through a common opening in a knuckle of intestine – each being carried down a separate limb of the gut – and are then approximated – followed by the closure of the incision in the knuckle. Following are the steps of the operation:

The sites of the anastomosis must be in such positions upon the antimesenteric aspects of the intestine that, when the length of the intestine is doubled upon itself, the site to be occupied by each button will not be beyond the reach of the special forceps to be introduced through an opening at the knuckle formed by bending the intestine upon itself. An incision in the longitudinal axis of the gut is now made at this knuckle. A button held in the grasp of the special forceps is then introduced through the opening down one limb of the gut _ the male button in the proximal limb. The female button, similarly held, is then introduced down the opposite limb. By pressure upon the forceps holding the male button, its stem is made to pierce the walls of its own side and the opposite gut _ and is then directed into the stem of the female button. The buttons are then pressed home _ the adjacent surfaces of intestine being held in contact without any form of suturing. The treatment of the opening in the kunckle of gut is as indicated. In the cases where the operation is simply a lateral anastomosis, the incision in the knuckle would be closed by interrupted or continuous Lembert sutures of gut or silk. In the majority of cases where this operation is done, however, it is performed in connection with a gastrojejunostomy, for the purpose of aiding in the prevention of bile and intestinal regurgitation from the duodenum into the stomach _ so that as soon as the intestinal anastomosis has been accomplished, the opening in the knuckle of intestine is sutured to a corresponding opening in the wall of the stomach, thus completing the gastrojejunostomy. (See Fig. 3543.)

Note.—The ordinary Murphy button may be used in practically the same manner. After opening the knuckle of gut, one-half of the button may be dropped into each limb of the intestine _ these are caught and held by the fingers of an Assistant at corresponding positions within the two pieces of gut, with the free portion of their stems held against the antimesenteric aspect of the gut. While the intestinal wall is thus drawn tightly over the hollow stems, a limited crucial incision is made in the center of the stems, just sufficiently large for the stems to be pressed through, with the walls of the intestine clinging closely around them _ immediately following which the two halves are pressed together, bringing the antimesenteric aspects of the two portions of gut into accurate apposition _ no reinforcing suture being necessary. The opening in the knuckle of gut is closed as usual. (See Figs. 3526–3527.)

Multiple Lateral Intestinal Anastomosis (Jaboulay-Braun's Operation).—In addition to the single lateral intestinal anastomosis formed after gastro-enterostomy, as above described (Braun's operation), sometimes a second, or even a third, lateral intestinal anastomosis may be made _ for the purpose of further avoiding the likelihood of intestinal regurgitation by furnishing as direct and easy a descent from the stomach to the anus as possible. Supposing, therefore, that a gastrojejunostomy has been performed, a lateral jejunojejunostomy may be done by Gallet's method of using Weir's modification of the Murphy button, at the time the intestine was opened to unite it to the stomach _ and then another jejunojejunostomy, or a jejunoileostomy, could be performed lower down by the ordinary lateral anastomosis method, or by button, thus short-circuiting by two routes the contents of the intestines.

Note.—Multiple intestinal anastomosis can, of course, be performed by simple suturing as well as by other methods.

End-in-side Implantation by Murphy Button.—Supposing the cecum to have been excised and the mesentery ligated, the male Murphy button is introduced into the free end of the ileum and tied in place, as in the ordinary end-to-end approximation. The edges of the free end of the cecum are then united by overhand continuous silk sutures through all the coats — and these are buried in by the interrupted or continuous Lemberts of gut or silk. An opening is then made 2.5 to 5 cm. (1–2 inches) from the sutured end of the cecum, upon its antimesenteric aspect, and the female button tied into place just as in lateral intestinal anastomosis. The two buttons are now brought together in the usual fashion. The line of union should be here reinforced by

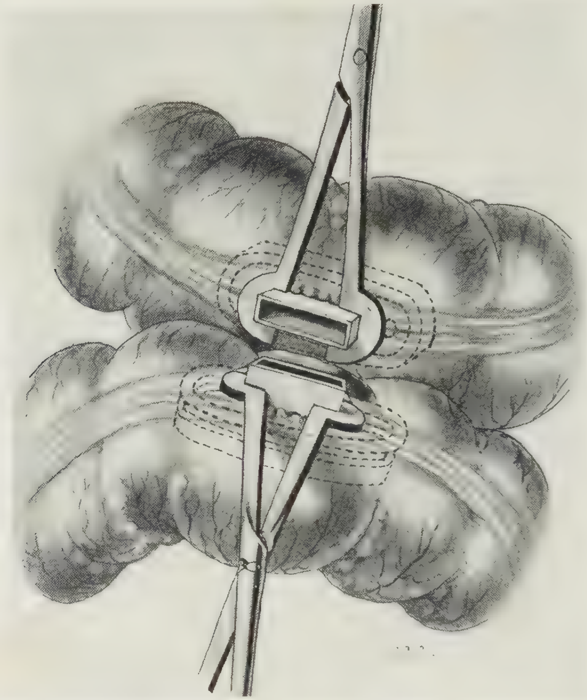


Fig. 3939.—Lateral Entero-anastomosis by Murphy's Oblong Buttons — the colonic mesentery and omentum being here omitted.

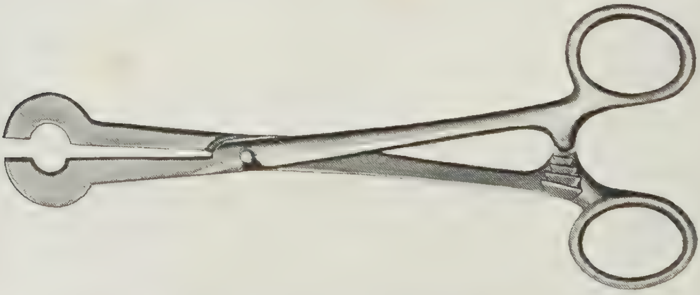


Fig. 3940.—Murphy's Button-introducing Forceps. (Redrawn from Kelly and Noble.)

a tier of interrupted Lembert sutures. The borders of the mesentery should be sutured as indicated.

Comments.—An oblong type of button is frequently employed in work upon the large intestine (Fig. 3939). It is sometimes, especially in awkward positions, difficult to hold the Murphy button, and this difficulty may be overcome by the use of a special form of button-holder, as seen in Fig. 3940.

Again, in some special forms of lateral entero-anastomosis, as, for instance, in lateral jejunojejunostomy, as a concomitant step of gastrojejunostomy (p. 326), the work may be expedited by passing a button puncturer down the two limbs of the jejunum, through the common jejunal opening made for anastomosing with the stomach, and puncture the intestine from within outward, for the passage of the shanks of the two halves of the button. Such an instrument is seen in Fig. 3941.

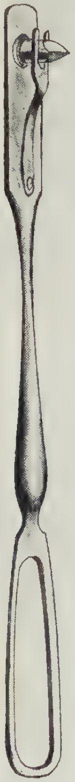


Fig 3941.—Murphy Button Puncturer

LATERAL INTESTINAL ANASTOMOSIS BY THE JABOULAY BUTTON

Description.—The Jaboulay button, made in three sizes, is made up of two halves, each half having an outer and an inner cylinder, the outer fenestrated cylinder having a break or slit in its continuity extending into and almost half around the inner cylinder. Its form of structure is intended to enable the button to be inserted upon "the screw and key-ring" principle through an especially small intestinal opening, and is used without the reinforcement of sutures (Fig. 3942).

Operation.—The coils of intestine are clamped and brought into the field in the usual way, with their antimesenteric aspects presenting. In using a button of 2.2 cm. (approximately $\frac{3}{4}$ inch) diameter, a longitudinal incision in the antimesenteric aspect of the bowel is made of 1 cm. ($\frac{3}{8}$ inch) length. The inner cylinder of the button is grasped with a pair of forceps, as in the case of the Murphy button – but, in the present instance, the button is insinuated into the lumen of the bowel by a semilateral cork-screw movement – the beak of the outer cylinder first entering – the screw-like movement being continued until the outer cylinder has entirely entered the cavity of the intestine – the inner cylinder being left protruding from the intestinal wound and snugly grasped by it. The opposite half of the button is introduced into the corre-

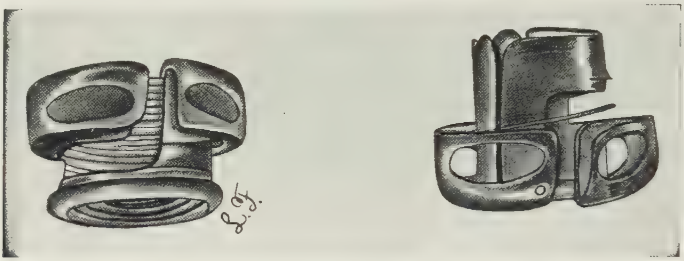


Fig. 3942.—The Jaboulay Button: Male and Female Halves. (Redrawn from Beer.)

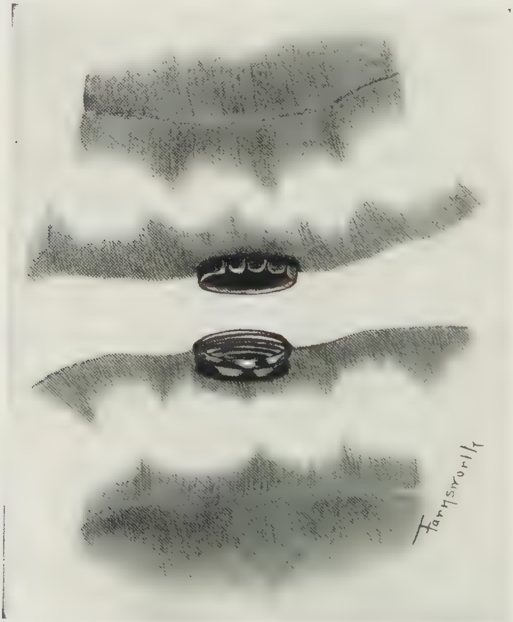


Fig. 3943.—Lateral Intestinal Anastomosis by Means of the Jaboulay Button: – Male and female buttons.

sponding lateral aspect of the opposite piece of intestine. The two halves are then pressed tightly home, with considerable strength (as the pressure necrosis which liberates the buttons is here dependent upon the amount of pressure used in approximating the buttons, and not upon a special spring or third cylinder, which continues to act, as in the Murphy button). The walls of the intestine are thus approximated and the lumen of each piece of intestine is connected through the inner cylinder. No reinforcement by suturing is used unless the intestinal wall be torn in inserting the buttons (Fig. 3943).

Comment.—Theoretically the above technic seems very satisfactory _ but the following practical difficulties (especially demonstrated by Beer's work) have arisen in the use of this form of button: In quite a large percentage of cases the button cannot be introduced through an incision bearing the proportion of the diameter of the button as indicated above (and as claimed for it by its author), and, in consequence, the intestinal wall is quite frequently split further than intended and has to be sutured. The button is quite often held *in situ* and is not passed. The especial advantages of the button are: the small incision, the rapidity of its introduction, and the absence of reinforcing suturing _ where all goes well.

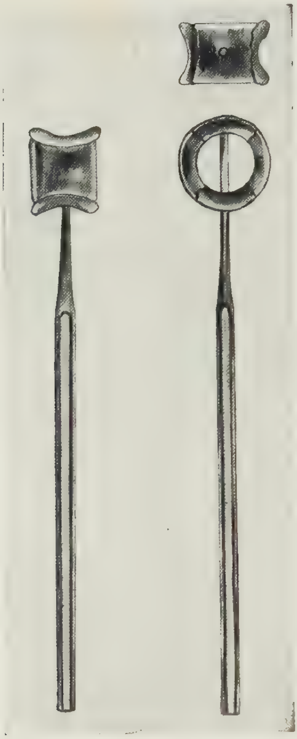
END-TO-END ENTERO-ENTEROSTOMY

BY HARRINGTON'S SEGMENTED RINGS

Description.—"The ring," in the language of its author, "is made of hard aluminum in four sections. These sections are jointed firmly together by a small bar of steel, which has a shoulder and a screw thread, and which serves as a handle. The outer surfaces of the ring are grooved to hold the ends of the intestines, which are tied in place by catgut purse-string sutures. The segments fit together by means of sliding tongue-and-groove joints so rounded that they will not cut, or catch in the tissues." The ring is a mechanical aid to intestinal anastomosis, end-to-end and lateral. Subsequently to being placed *in situ* it collapses into its component segments, which are so small that they are passed without danger or discomfort. The rings are made in three sizes (Figs. 3944 and 3945).

Operation.—The description of the technic given by Harrington and Gould will be here largely followed. The end-to-end anastomosis is performed as follows (Fig. 3946): _ Clamps are applied in such a way as to exclude the general intestinal tract. A seromuscular purse-string suture of No. 2 plain catgut is placed around the intestines on either side of the area to be excised, and the first part of a Surgeon's knot tied, without tightening the suture. The intestine is excised 3 mm. ($\frac{1}{8}$ inch) from the purse-strings. A mesenteric mattress-stitch, after the manner of the Maunsell mesenteric stitch, is first applied. The segmented ring is then introduced into one end of the intestine, guided by the handle, and the purse-string of that end is tied. The mesenteric mattress-suture is then tied, after which the other end of the segmented ring is placed within the lumen of the opposite end of intestine and the second purse-string suture tied. The intestinal margins are evenly adjusted to each other at the center of the ring. A Cushing right-angled continuous seromuscular suture, beginning to one side of the steel handle, is carried around the intestine, with frequent knotting, to the opposite side of the handle. The handle of the instrument is then unscrewed and withdrawn _ after which the Cushing suture is continued over the opening left by the withdrawal of the handle. The ring is held together by the purse-strings.

Lateral intestinal and gastro-intestinal anastomoses are accomplished in the same general way. The purse-string sutures here consist of two parallel



Figs. 3944 and 3945.—Harrington's Segmented Ring; — Seen in three positions with handle in position in two.

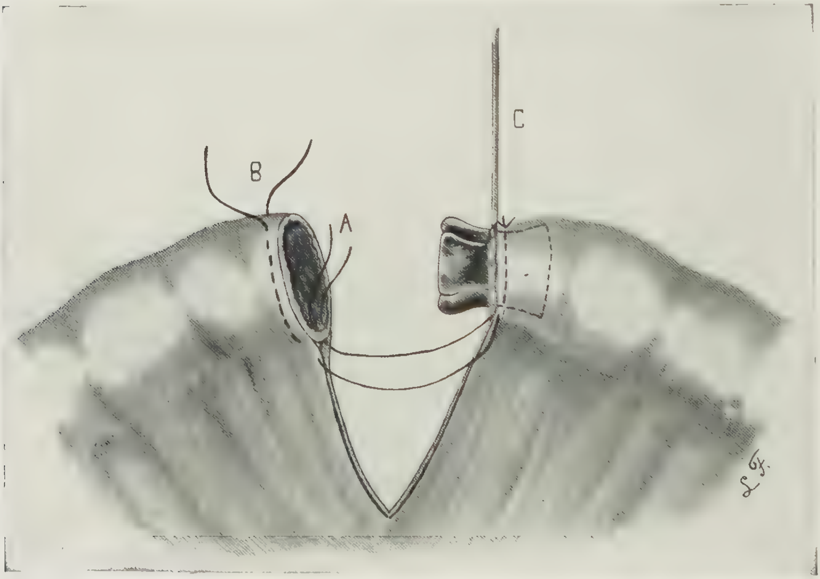


Fig. 3946.—Entero-enterostomy by Means of Harrington's Segmented Ring: — A, Mesenteric stitch; B, purse-string suture (the one on the opposite end being tied); C, the ring and handle in position. Redrawn from Gould.)

arms crossing at one end, only far enough from each other to leave room for the incision.

Comment.—It is better to leave the ring in place after completing the operation _ although if it seem to exert undue pressure, it may be collapsed by gently compressing it through the walls of the intestine. At the end of twenty-four hours the swelling is great enough to hold the intestinal ends together without the purse-string sutures. But at the end of from four to six days the swelling subsides, leaving the purse-strings and the lumen of the intestine considerably larger than the circumference of the ring _ which then collapses and passes on down.

(D) ENTERO-ENTEROSTOMY BY MECHANICAL MEANS, TEMPORARILY USED, FOR APPROXIMATING THE INTESTINAL EDGES DURING SUTURING

IN GENERAL

Description.—Various more or less ingenious forms of devices have been introduced for the purpose of holding in contact the opposite margins of the intestines during the act of suturing _ to be withdrawn just prior to the completion of the suturing. Many of these, at the same time, distend the otherwise flaccid bowel, and render the application of sutures easier _ such as the Halsted inflatable rubber cylinder, Laplace's intestinal forceps, Lee's intestinal holder, and the like. The last of these will be described as representing this class of work.

END-TO-END ENTERO-ENTEROSTOMY BY MEANS OF LEE'S INTESTINAL HOLDER

Description.—The instrument, though simple in principle and construction, is difficult to describe clearly _ but its manipulation is easy. The holder is introduced into the approximated ends of the intestine closed _ is then opened _ and serves as a framework upon which suturing is done _ and is then finally closed and withdrawn. A single instrument fits any part of the intestinal tract _ and any suture may be used in conjunction with it. Lee uses a modification of the Connell stitch. The method is only applicable to end-to-end approximation.

Operation.—Open the abdomen _ clamp off the site _ and excise a portion of the intestine, with or without a part of its mesentery. (See Fig. 3947.) The mesenteric suture is passed _ exactly as the mesenteric traction suture is passed in Maunsell's operation (p. 715). Both ends of the silk are left long and are knotted within the lumen of the gut _ thus approximating the mesenteric aspects of both guts and both laminæ of the mesentery to the barrel of the gut (Fig. 3948). Each end of the threads is then needled _ and the needles are made to pass out of the gut near the knot and the threads are drawn after.

The intestinal holder is now introduced and opened _ distending each gut flatwise _ the distal arms being against the mesenteric border and the proximal arms against the antimesenteric border _ the free borders of intestine lying in parallel contact _ there being no marked tension anywhere. The half of the intestine nearer the Surgeon is now sutured with right-angled continuous suture (Fig. 3949), passing through all the coats, tightening the thread after each stitch. When the site of the emergence of the stem of the instrument is reached, the final stitch is made on the side opposite to the one on which the preceding stitch was made _ and this final stitch is only a half-stitch, passing from without and ending on the interior of the gut (Fig. 3949). The instrument is now so turned as to present the opposite side (Fig. 3950) _ which is sutured in a similar manner _ the final half-stitch ending on the same end of gut as the last half-stitch of the first side, and on the interior of the gut.

The instrument is now folded and withdrawn (Fig. 3951) _ leaving two free ends of silk ready to be tied. To enable the ends to be knotted on the interior a threaded needle is insinuated between the stitches of the opposite side, the eye first _ and is pushed upward until the threaded eye protrudes through the opening formerly occupied by the handle of the instrument. The thread of the needle is then loosened into a loop, under which the free ends of the two sutures are passed _ and by means of which these free ends are drawn out when the needle is withdrawn through the line of suturing,

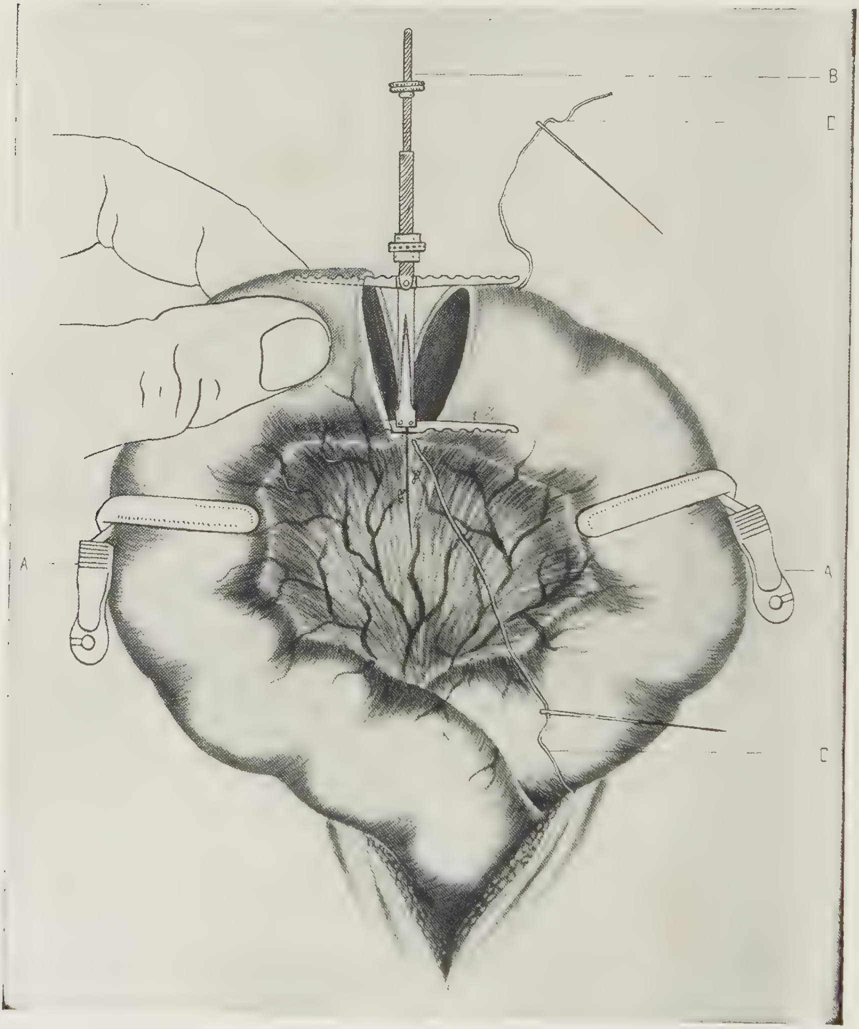


Fig. 3947.—End-to-end Entero-enterostomy by Lee's Intestinal Holder: _ A, A, Clamps upon a coil of intestine from which a portion has been excised; B, intestinal holder being inserted into the ends of intestine _ its blades extended; C, C, the two ends of the mesenteric suture. (Modified from Lee.)

at the point where the head of the needle was pushed through. These sutures are then knotted, during which process the bowel is flattened and its mucous membrane near the final half-knots is approximated to the site where the sutures are being tied – the sutures are then cut short – and the knots slip into place and the intestine regains its form by a little manipulation (Fig. 3952).

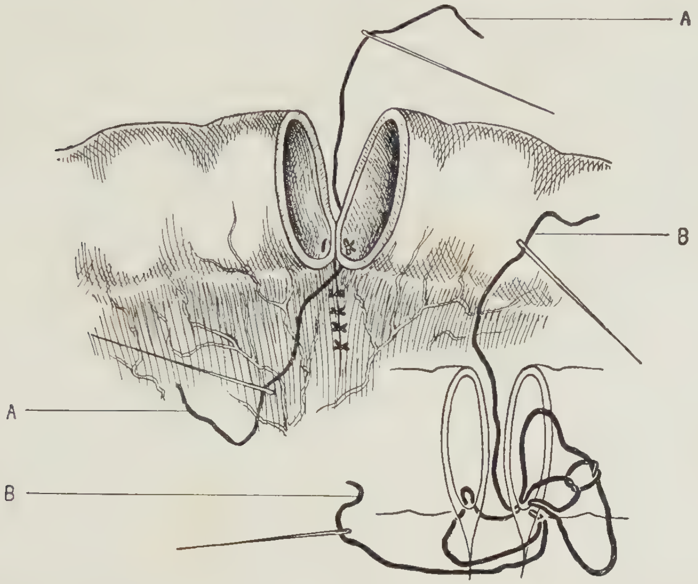


Fig. 3948.—Entero-enterostomy by Lee's Intestinal Holder: – A, A, Mesenteric suture tied and ends passed out of intestine; B, B, showing, first, manner of tying mesenteric suture – and, second, manner of passing ends of suture out of intestine. (Modified from Lee.)

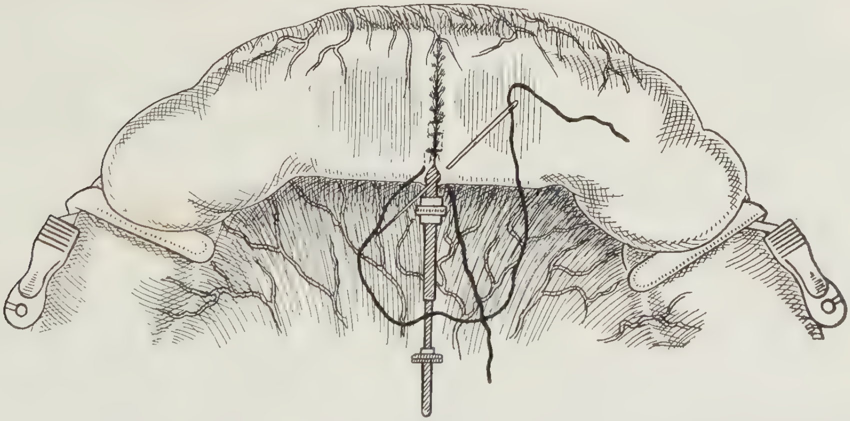


Fig. 3949.—Entero-enterostomy by Lee's Intestinal Holder; – Manner of placing and ending the right-angled continuous sutures upon the aspect of the intestine further from Surgeon. (Modified from Lee.)

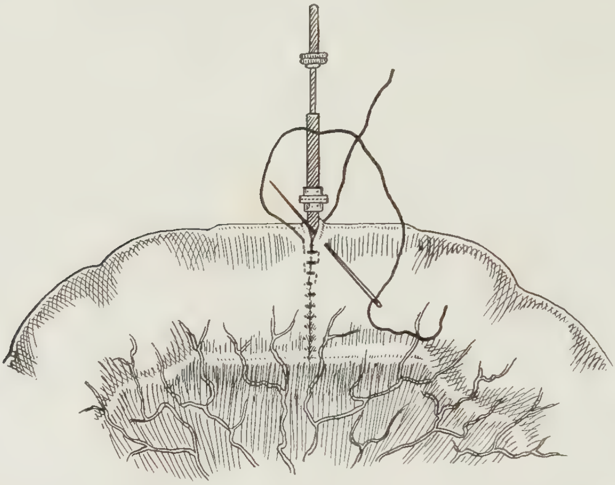


Fig. 3950.—Entero-enterostomy by Lee's Intestinal Holder; — Manner of placing and ending the right-angled continuous sutures upon the aspect of the intestine nearer the Surgeon. (Modified from Lee.)

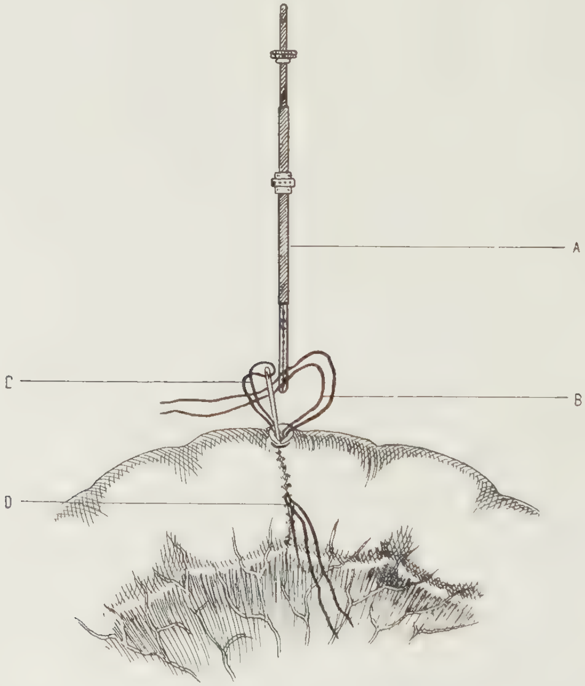


Fig. 3951.—Entero-enterostomy by Lee's Intestinal Holder: — A, Holder closed and withdrawn from intestine; B, ends of the two sutures emerging from the same side and within the intestine; C, loop introduced upon the head of needle through suture line at D, under which loop the ends of the main suture are caught and withdrawn at D. (Modified from Lee.)

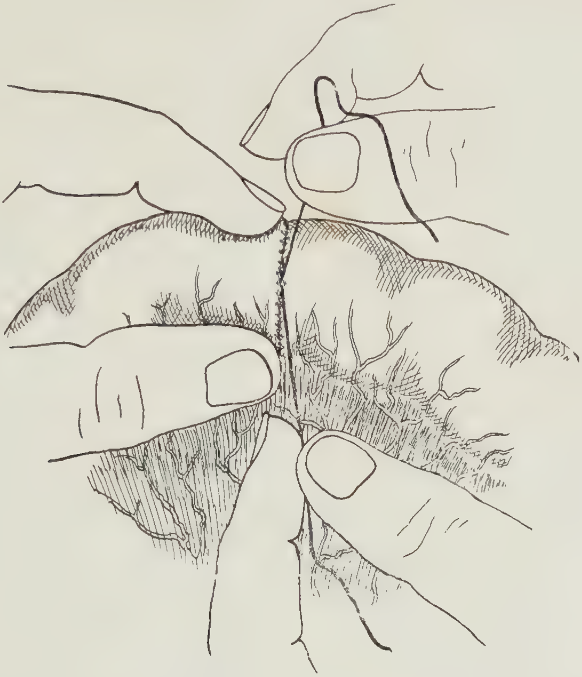


Fig. 3952.—Entero-enterostomy by Lee's Intestinal Holder; _ Tying the final knot upon the outside _ which, upon cutting the threads, recedes within the intestine. (Modified from Lee.)

Comment.—Any other less intricate form of suturing may be used. Reinforcing Lemberts may be used if thought necessary.

(E) ENTERO-ENTEROSTOMY BY OTHER MEANS

Description.—A method of accomplishing entero-anastomosis _ hardly classifiable under any of the preceding categories _ is McGraw's technic of intestinal anastomosis _ which will be next described.

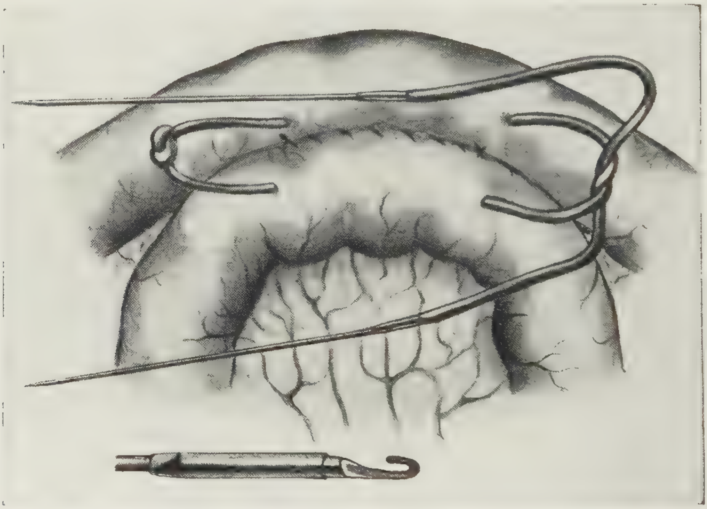
LATERAL ENTERO-ANASTOMOSIS AIDED BY ELASTIC LIGATURE

Description.—In this procedure a special form of elastic ligature is so placed and tightened between the apposed loops of intestine, and surrounded by sutures, that in its subsequent compression, it cuts its way out and is passed _ leaving a communicating opening between the two coils of intestine. Its chief advantage is, the rapidity with which it can be placed _ within three minutes _ which, in some desperate cases, is of major consideration. Its main disadvantage is, that from three to five days must pass before it cuts its way out _ and, until it does do so, no satisfactory opening between the anastomosed loops exists (which may constitute a contraindication to its employment where that length of time cannot be waited for communication to be established). Sometimes the ligature has failed to cut its way entirely fout.

The technic, as originally elaborated by Gaston and by McGraw, has been urther improved by the special needles adjustable to the ligature, devised by McLean _ and by the special central knot suggested by F. T. Murphy. The ligatures are made in three sizes – the largest and strongest cutting its way out soonest.

The chief indication for the employment of this method are cases of acute intestinal obstruction in indifferent subjects unable to stand prolonged methods – where this anastomosis is made, and the intestine is at once opened as an artificial anus proximal to the anastomosis.

Operation.—The intestinal loops to be anastomosed are so placed that their antimesenteric aspects will be in relationship. A posterior line of Lembert sutures is placed uniting the two coils of intestine along what will form the posterior line of the anastomosis – the suture being knotted and left long at one end, and threaded and left long at the other. An appropriate elastic ligature is taken – knotted at its center – and having a ferruled McLean needle slipped over each free end. Introduce the point of one of the needles into the lumen of one of the intestinal loops, by a controlled stab-puncture (so that the mucosa will be certainly punctured – and not merely pushed ahead of the needle point, which would probably defeat the object of the technic). The needle then travels in the free lumen, parallel with the Lembert suturing, for about 5 cm. (2 inches) and then makes its exit – the point of entrance and exit lying well within the length of posterior suturing (Figs. 3953 and 3954). The opposite needle is carried through the opposite coil of intestine in the same manner. The needles should enter and leave the intestine as nearly as possible at a right angle to its axis, so as to avoid obliquely piercing the intestinal walls. The knot is held between left thumb and finger, while the right thumb and finger make the rubber cord thinner by drawing upon it, as the ligatures are drawn into place, and as the knot is drawn up against one end of the anastomosis. When all is in readiness, a stout piece of silk, preferably waxed, is laid as shown in the illustration – and over this the ends of the rubber ligature are tied in the first stage of a Surgeon's knot, as tightly as



Figs. 3953 and 3954.—Lateral Entero-anastomosis, Aided by Elastic Ligature – McGraw's Technic – I; – The posterior tier of Lembert silk suturing has been placed. The elastic ligature has also been placed, and is ready for the tightening of the first friction-knot, over a piece of stout silk – which, in turn, will be tied over both the first and second phases of the rubber Surgeon's knot. The head of the McGraw needle is seen below.

they can be drawn _ after which the silk is tightly tied over this first rubber knot with a square knot of its own _ to be followed by the second phase of the Surgeon's knot, of the rubber ligature _ to be followed, in turn, by a second square silk knot over the completed rubber knot. There is a tendency to draw the posterior line of Lembert suturing into the knot _ and, to prevent this, the flat handle of a knife, or of a pair of anatomic forceps, or like instrument, is carefully pushed down against this posterior suture line, to hold it out of the way of being caught and tied in with the knottings (Fig. 3955). An Assistant is on the lookout for any intestinal oozing during these maneuvers _ which, if they occur, are wiped away with wet gauze. The ends beyond both the rubber and silk knots are cut short _ but not short enough to risk slipping. Finally, the threaded end of the posterior Lembert suturing is taken up, and continued anteriorly around the site of anastomosis _ thus completely surrounding it (Fig. 3955).

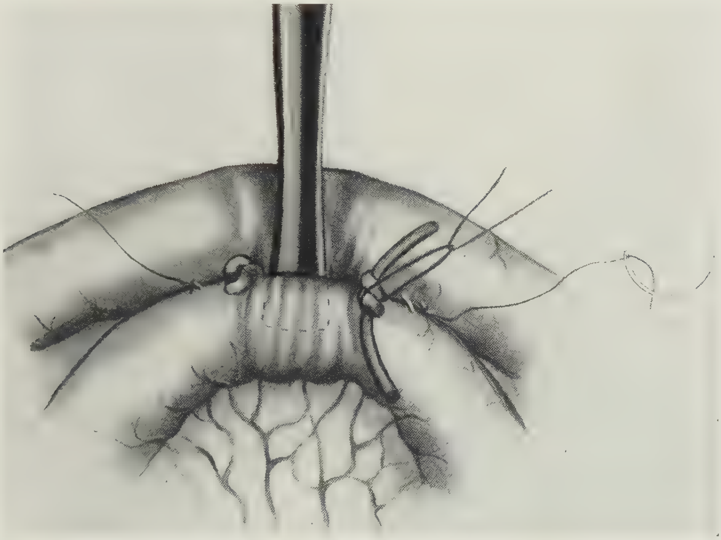


Fig. 3955.—The Same _ II; _ While the posterior line of Lembert suturing is being held out of the way (from being drawn into the knot) by some flat-handled instrument, the various knots connected with the rubber ligature and its reinforcing silk ligature, are tightened and tied _ after which the Lembert suturing will be continued around the anterior aspect of the anastomosis.

OPERATIONS FOR THE CLOSURE OF FECAL FISTULA AND ARTIFICIAL ANUS

Description.—Although the arrangement is somewhat artificial, no hard-and-fast line of difference existing, it is conventionally understood, as a means of differentiation, that *fecal fistula* applies to those artificial communications which exist between the intestinal canal and the skin, in which no obstruction to the onward passage of feces is present, and where, therefore, the major portion of the intestinal contents passes onward past the fistula, along its natural channel, and only the minor portion escapes along the fistulous tract, _ while, on the other hand, *artificial anus* applies to those cases of artificial communication between intestinal tract and skin, where some degree of intestinal obstruction exists, sufficient to cause all or the major part of the intestinal contents to pass out through the unnatural opening.

Fecal fistulæ probably most frequently occur in connection with the small intestine, and artificial ani, in conjunction with the large intestine, though each may occur in all parts of the intestinal tract.

Causes of Fecal Fistulæ and Artificial Ani.—Fecal fistulæ may be the result of disease (causing ulceration of the bowel wall), (upon either the intestine or upon adjacent structures) operation, wounds, or may be congenital. A fecal fistula may be at first entirely intra-abdominal, and then eventually communicate with the skin, as may occur in connection with a ruptured appendix, followed by abscess. Artificial ani may occur from exactly similar causes, but, in the majority of cases, are the results either of the spur formation intentionally produced in performing the operation of colostomy, or of sloughing strangulated herniæ (where, somewhat similarly, a spur often follows the sloughing, serving as an obstruction to the onward passage of feces).

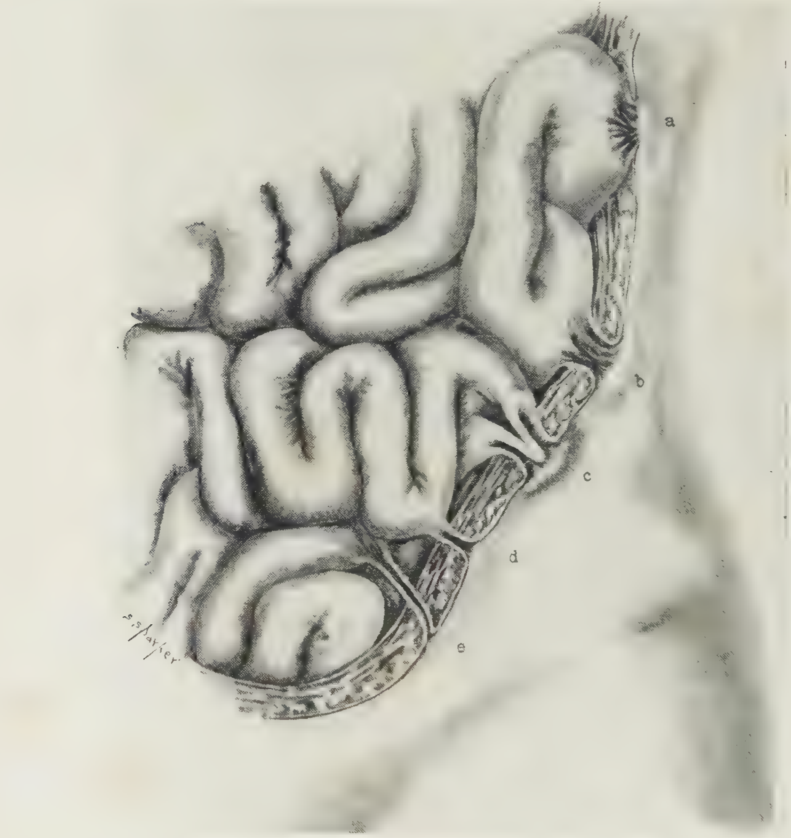


Fig. 3956.—Forms of Fecal Fistulæ and Artificial Ani: **a**, Direct communication between the intestine and skin by a shallow fistulous tract, with the bowel not appreciably bent out of its course, and with a broad muscle wall gap; **b**, communication between the intestine and skin by a broad tract at least as deep as the thickness of the abdominal wall, and the bowel but little bent out of its course; **c**, the bowel is acutely bent into proximal and distal limbs, and a pronounced spur is present, reaching nearly or quite to the skin level; **d**, the bowel is bent not out of its course, but a short, narrow sinus communicates between the skin and an adjacent coil of the intestine; **e**, a longer, narrower channel communicates between skin and a distant loop of intestine.

Varieties of Fecal Fistulæ and Artificial Ani (Fig. 3956).—Four chief forms of these pathologic communications between the small or large intestine and skin are encountered: (1) The bowel is not bent upon itself to any extent; there is no spur; but little of the intestinal wall is involved; the opening is small; the skin and intestinal mucosa are connected by a sinus-like communication of greater or less length. The characteristic feature of this class is the fistulous tract between intestine and skin. (2) The bowel is bent somewhat more upon itself; more of the intestinal wall has been lost; the opening is larger; while there is no distinct spur, there is the tendency to one, recognized by a finger introduced, which will be directed proximally and distally by the band formed by the opposite wall of the intestine; the bowel does not tend to prolapse; the fistulous opening is larger and shallower; the skin and the intestinal mucosa are more nearly in contact, or may be in direct continuation of each other. This class has neither the fistulous tract of the preceding nor the spur of the following class. (3) The bowel is more acutely bent upon itself; the proximal and distal limbs approach the outlet of an acute angle, the former distended, the latter, partly collapsed, from disuse (practically all the feces escaping through the fistulous opening); a marked spur is present, reaching, approximately, the skin level, and constituting an obstruction to the intestinal passage; the amount of intestinal wall lost is variable; the condition present is usually an exaggeration of the preceding class. The characteristic of this class is the pronounced and prominently projecting spur. (4) In this class of cases the bowel is not diverted from its usual course, and is not attached to the abdominal wall, but a fistulous tract communicates between the surface and some distant part of the bowel by a rather prolonged tract.

It will, therefore, be seen that the operative repair of fecal fistulæ and artificial ani will materially differ in magnitude, though not in principle, according to the kind and degree of the pathologic involvement. While the simplest forms of such fistulous tracts tend to close of their own accord, the more complicated or pronounced ones may require some considerable operative effort to accomplish this. The inability of asepticizing the field adds to the difficulties.

Operations for both fecal fistulæ (usually of the small intestine) and artificial ani (generally of the large intestine) will be here considered, although it might be more logical to consider the treatment of artificial ani after the description of the different forms of colostomy, following which the need for operative repair of the resulting artificial anus most frequently occurs. The general principles involved in the operative treatment are the same, though the cure of a fecal fistula is usually a simpler, smaller undertaking than may be the larger, more complicated treatment of an artificial anus.

Preparation.—The neighboring skin should be gotten as healthy as possible preliminarily. The entire intestinal tract should be evacuated, the fistulous tract irrigated, and the vicinity of the field shaved. Just preceding the operation the sinus may be cureted gently and again irrigated, or may be gone over with pure carbolic acid, followed by alcohol and normal saline solution. The lips of the fistula are tightly and deeply sutured with silk or linen, and the long ends of the sutures, after tying, are knotted, and grasped with a clamp, to be used as tractors during the operation.

Position.—The patient lies at the edge of the table nearer the fistulous tract, with this tract presenting. Surgeon upon the side of the fistula, Assistant opposite.

Landmarks.—Site of the fistula; known relations of the neighboring parts history of the preceding condition or operation.

Operation.—While the operative procedures for repair of the different types of fecal fistulæ and artificial ani have much in common, some of the types have distinctive features – and these are best met by special technics. The operative treatment of each of the four above types will be separately considered. The details, however, of the operations for the spur-type of artificial anus, which is the type which usually follows the colostomy operations, will, more naturally, be discussed and illustrated, immediately following the description of the various procedures for colostomy (v. Index, Vol. V).

The two most distinctive classes of operations employed in these connections are: Operations involving the peritoneal cavity, either because no adhesions exist, or because it is desired to free existing adhesions before excising the fistulous tract. Operations not involving the peritoneal cavity, because of adhesions extending around the fecal sinus and the possibility of excising the sinus and closing the intestinal wound without passing beyond the adhesions. The destruction of the spur by various mechanical means, connected, more frequently, with colostomy operations, will be described after those operations.

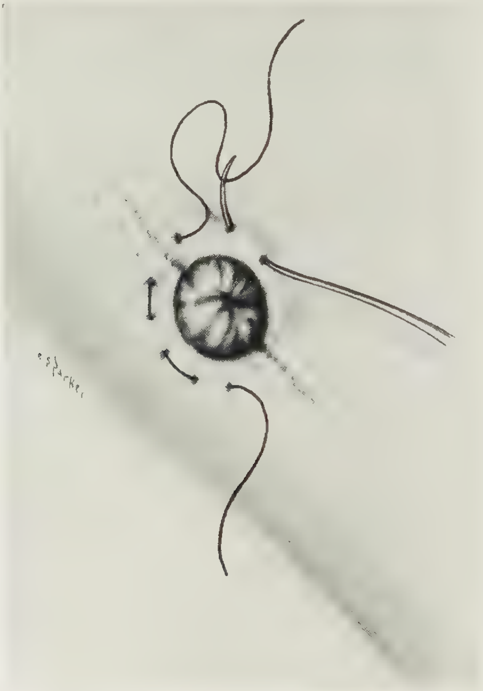


Fig. 3957.—The Closure of the Cutaneous Opening of a Fistulous Tract – after disinfection, and prior to operation. The closure is here accomplished by a purse-string suture placed by a Reverdin needle. Interrupted sutures may also be employed.

(*a*) **Transperitoneal Operation for Fecal Fistula, or Artificial Anus, with a Distinct Fistulous Tract Between Intestine and Skin** (Group 1, in the Above Classification, p. 749).—An elliptic incision is made around the fistulous opening – its long axis will generally be vertical, in operating upon fistulæ of the small intestine, and will usually correspond with the long axis of the large bowel, in operating upon parts of the colon – and the length and breadth of the ellipse will be planned, as far as can be foretold, to extend beyond the adhesions probably surrounding the sinus.

Having sutured the fistulous opening (Fig. 3957) _ and using the sutures as traction loops, the incision is carefully deepened on each side _ clamping bleeding vessels _ and guarding against opening the peritoneum prematurely, or cutting into an adherent coil of intestine (Fig. 3958). In passing through the thickness of the abdominal wall, the course of the incision is directed by the sensation and form of the distended fistula and by the left index-finger within the wound (Fig. 3958). In difficult cases, and especially in devious fistulæ, it may be necessary to introduce a sound, or bougie, through the sinus as a palpable guide. Having deepened the incision all around, down to the peritoneum, the abdominal cavity is now carefully opened in the line of the original ellipse. If the ellipse lie without the site of adhesions, no great difficulty will be experienced. If it lie in part over adhesions, a finger introduced through the site leading into the free peritoneal cavity and swept around the sinus will serve for exploration and as a guide to the separation or incision of the adherent portion. If the ellipse lie wholly over adhesions and come down upon these all around, great care is required to recognize the plane of adhesions when reached, and greater care still in separating or dividing them in the line of the ellipse.

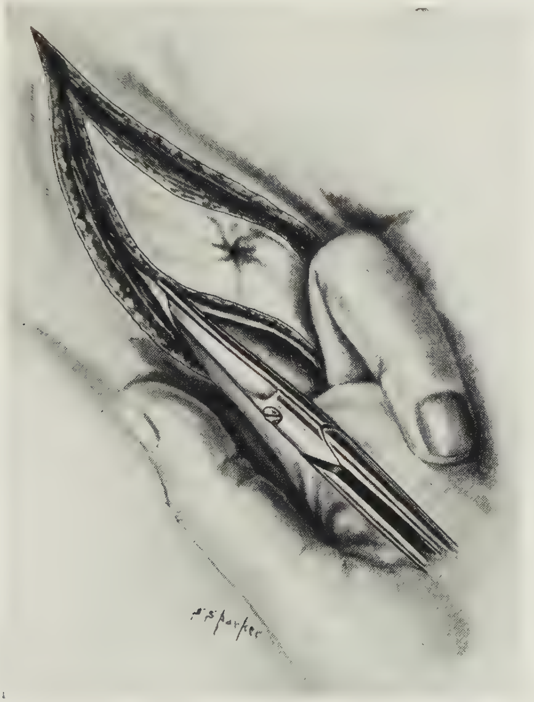


Fig. 3958.—Transperitoneal Operation for Fecal Fistula, or Artificial Anus, with a Distinct Fistulous Tract Between Intestine and Skin _ I; _ The elliptic incision, circumscribing the skin opening of the fistulous tract, has been carried through the abdominal wall at one site, and the surgeon's left index is passed into the peritoneal cavity, to determine the relations and to guide the knife or scissors.

Having thus reached the intestines, an isolated oval island of tissues (included in the original ellipse and in deepening the ellipse to the intestinal wall) will be evident _ free above and continuous with the intestine below _ through the center of which the sinus extends. The intestine is carefully

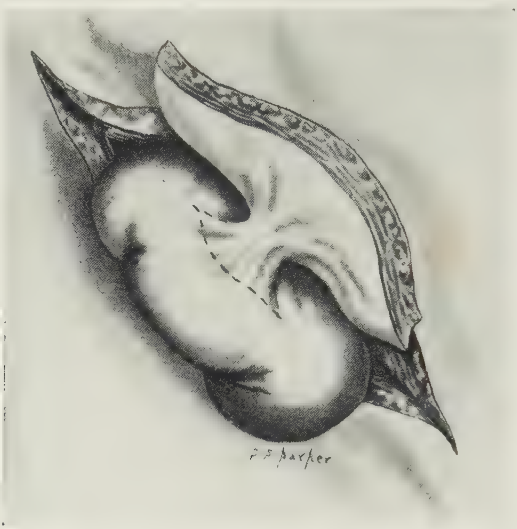


Fig. 3959.—The Same _ II; _ The elliptically excised cutaneous outlet and neck **of the intestinal** fistula _ showing its "umbrella," or "mushroom" spread into the intestinal tract _ and **the dotted ellipse** along which this neck will be cut away from the intestine.

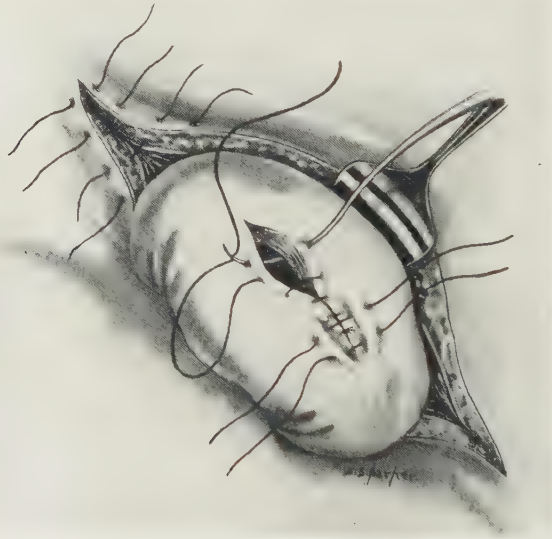


Fig. 3960.—The Same _ III; _ The site of the excised fistula is being closed by marginal and by Lembert sutures _ after which the coil of intestine will be returned to the peritoneal cavity _ and the abdominal wound closed.

freed and drawn out into the abdominal wound, with the oval island of tissues still adherent (Fig. 3959) _ and the neighboring parts packed off with gauze.

Having pressed away the intestinal contents and clamped the gut above and below the site of the sinus, a small elliptic incision is made in the gut, circumscribing the connection of the sinus with the gut, and having its long axis coincident with that of the gut – and the incision is deepened through the wall of the gut, thus excising an elliptic piece of the intestinal wall, representing the intestinal end of the sinus. The escape of intestinal contents is especially guarded during this excision. The wound of the intestine is at once closed by a double row of sutures – a continuous overhand suture of all the coats, thus bringing together the free edges – followed by interrupted Lemberts of the outer coats (whether peritoneum or the connective tissue of adhesions forms the outermost coat—Fig. 3960).

In Fig. 3961 the entire operation is suggested in a single picture.

The abdominal wound is closed in the usual manner.

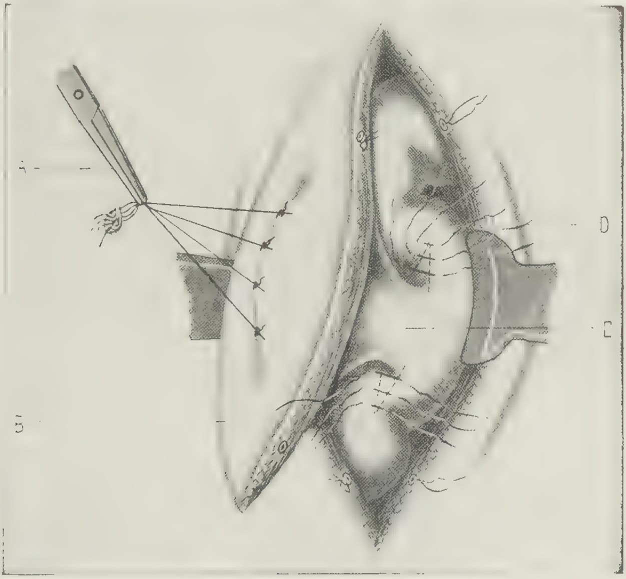


Fig. 3961.—The Same; – Summary of the entire operation – here performed through a vertical incision – seen in a single view.

Comment.—If there be any question that the closing of the elliptic wound of the intestine in conformity with the axis of the bowel may be followed by too great narrowing of the intestine, the wound should be sutured transversely – as is done in enteroplastic operations for narrowed intestinal caliber.

In some cases of considerable involvement, in the way of intestinal distortion, or extensive adhesions, at the intestinal end of the fistulous tract, it may be wiser, as well as simpler, to excise a limited portion of the bowel, and then perform an end-to-end entero-anastomosis (Fig. 3962).

It is safer to enter the peritoneal cavity at the two ends of the ellipse – which are apt to be further from possible or likely adhesions than the sides of the ellipse.

(*b*) **Transperitoneal Operation for Fecal Fistula, or Artificial Anus, by Braun's Method.**—The abdomen is opened at the site of the fistula – and the fistulous opening, and the two contributing limbs of intestine are freed from the abdominal wall, and from adhesions, if any. The two barrels of intestine (which may already be partly united by adhesions at this site, and, if so, these particular adhesions are not disturbed) are then united by a tier of sutures passing through the outer coats only (Fig. 3963), further uniting the adjacent aspects of the two limbs. An incision is now made through the free wall of each intestinal limb, just outside of the first tier of suturing –

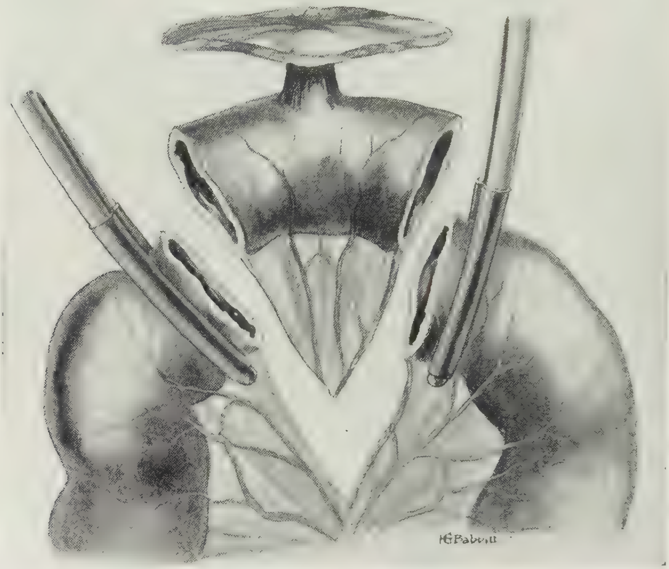


Fig. 3962.—LATERAL VIEW OF A PARTIAL INTESTINAL RESECTION, INCLUDING THE FISTULOUS TRACT TO BE FOLLOWED BY END-TO-END ENTERO-ANASTOMOSIS.

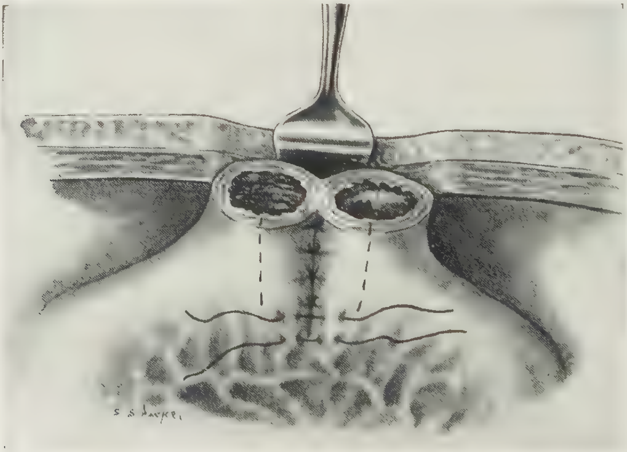


Fig. 3963.—TRANSPERITONEAL OPERATION FOR FECAL FISTULA, OR ARTIFICIAL ANUS, BY BRAUN'S METHOD – I; – Placing the first tier of non-penetrating sutures, further uniting the two intetinal limbs – preparatorily to axially incising the two barrels of intestine along the dotted lines.

and of such length as the special conditions present will determine (Fig. 3964). Next, the borders just outlying the first line of non-penetrating sutures are brought together by a line of through-and-through marginal stitches _ as shown in the last quoted picture. Finally, the upper and outer aspect of this rather extensive opening is closed by two tiers of sutures _ the first passes through all the coats, marginally (Fig. 3965) _ and the second, non-penetrating.

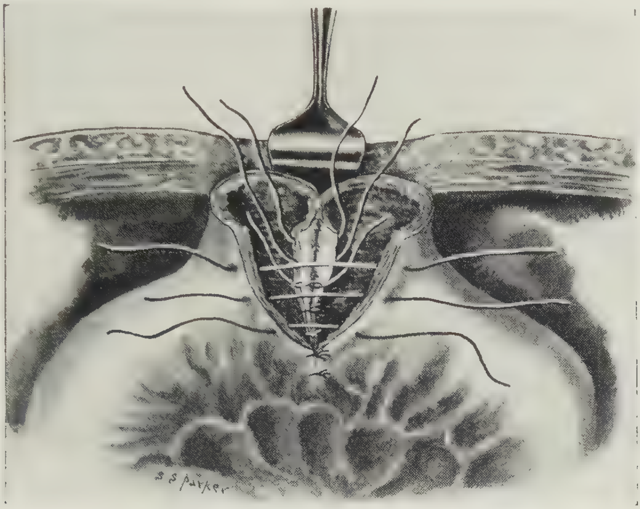


Fig. 3964.—The Same _ II; _ The double incisions have been made _ and the inner and outer marginal sutures are being placed _ which will close in or "hood" over the double barrels _ after which this marginal tier will be reinforced by a tier of Lembert suturing.

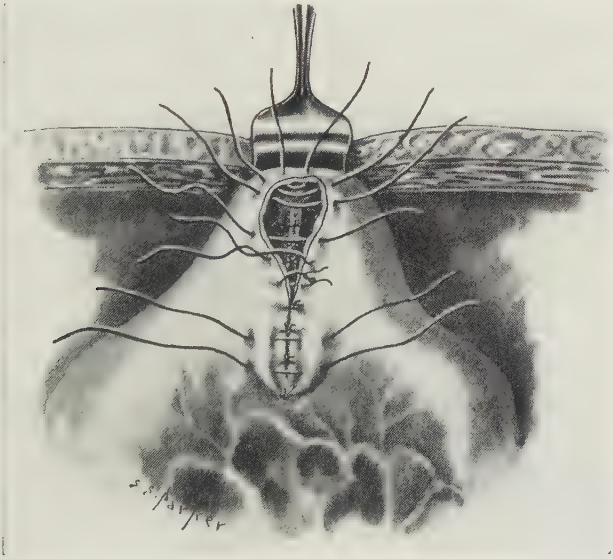
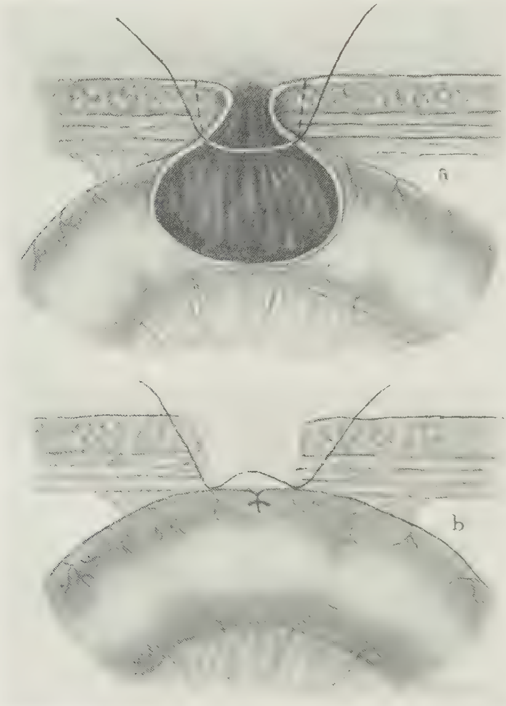


Fig. 3965.—The Same _ III; _ The anterior tier of marginal sutures is being placed _ to be reinforced by Lemberts _ thus closing in the front and dome of the two intestinal coils _ before dropping them back into the cavity _ and closing the abdomen.

through the outer coats. The intestinal tract is thus restored, all adhesions connecting the parts with the abdominal wall are removed _ and the sutured bowel dropped back into the cavity _ which is then closed.

(*c*) **Extraperitoneal Operation for a Simple Type of Fecal Fistula, or Artificial Anus, Where No Distinct Fistulous Tract Exists, and Where the Fistula is Shut Off from the Peritoneal Cavity by Adhesions _** (Group 2, in the Above Classification).—This procedure is indicated, and possible, in comparatively few cases. The operation is conducted as above, except that a smaller incision is employed _ and care is exercised to avoid entering the abdominal cavity, which can be done only when more or less extensive and strong adhesions exist (Fig. 3966, **a**). The sinus is followed down to its intestinal end by cutting directly through all intervening tissues to the intestinal wall, which is then incised in such a way as to elliptically excise the intestinal end of the fistula _ guarding against injury to neighboring coils of intestines and viscera.



Figs. 3966 and 3967.—Extraperitoneal Operation for a Simple Type of Fecal Fistula, Without a Distinct Fistulous Tract, and Not Involving the Peritoneal Cavity: _ **a**, Sectional view of the site, dotted lines indicating the marginal sections; _ **b**, the section completed, the intestinal opening sutured, and the abdominal wall about to be closed.

Having excised the sinus without entering the peritoneal cavity, the margins of the intestinal wound are first united, and then the borders of the wound on a plane with the upper wall of the intestine are inverted and sutured together by interrupted chromic gut or silk sutures, applied after the manner of Lembert's, approximating surfaces, which, while not peritoneal, have been left raw from the excision of the sinus (Fig. 3967, **b**). The sinus is closed throughout the rest of its extent by deeply buried chromic gut sutures.

Comments.—While the intention is not to open the abdominal cavity, this is frequently done by accident, during the steps of manipulation, which may prove difficult, or impossible to carry out without entering the cavity, in freeing the neck of the fistula from the surrounding adhesions, without breaking through the latter. So that the operation often ends in being carried out exactly as the one last described.

Further, one of the disadvantages of this technic, if successful as planned, and without opening the abdomen, is, that it leaves the bowel adherent to the abdominal wall.

If this technic be undertaken, it is probably always better, if successful in excising the tract and placing and tying the marginal sutures of the intestinal end of the excised tract, to then delibreately free the intestine from its adhesions, and place the second tier of sutures without the embarrassment of working within a walled-in area.

(*d*) **Operation for Fecal Fistula, or Artificial Anus, in the Presence of an Acute Angulation of the Intestine and a Pronounced Spur** (Group 3, in the Above Classification).—These conditions are so very much more constantly encountered as the characteristic result of the colostomy operations, that they will be considered immediately after those operations (p. 749).

(*e*) **Operation for a Long Fistulous Tract, Extending from the Skin to a Distant Part of the Intestinal Tract** (Group 4, in the Above Classification).—These are usually complicated cases _ and must be met upon their individual grounds. The general plan of action consists in performing an abdominal section, followed by the careful dissection of the sinus, from the skin, to its source of origin _ the excision of the sinus _ and the closure of the resulting visceral and abdominal wounds.

(*f*) **Operation for Fecal Fistula, or Artificial Anus, by Intestinal Exclusion.**—This technic is separately described under a special heading (v. p. 757).

INTESTINAL EXCLUSION

Description.—By intestinal exclusion, or occlusion, is understood the complete diversion of the intestinal contents, by means of a short-cut way, from some limited part of the intestinal tract, without interfering with the intestinal flow in the rest of the tract _ which is accomplished by uniting two parts of the bowel, so that the contents of the proximal or upper part of the bowel will empty into the distal, or lower part, without passing through the intermediate or short-circuited portion. The intermediate or short-circuited part of the intestine is said to be "partially excluded" when some proportion of the intestinal flow occurs through one or the other end of the short-circuited portion, into the rest of the tract (as in ordinary lateral entero-anastomosis) _ and "completely excluded," when no part of the flow passes through either end of the completely isolated part, into the rest of the tract. In unilateral intestinal exclusion (Figs. 3969 and 3970) the intestine is divided in a single place, the distal end of the divided bowel is closed, and the proximal end is anastomosed with the main intestine above (proximal to) the division. In bilateral intestinal exclusion both the proximal and distal ends of the excluded portion of the bowel, after division of the intestine at each end of the loop, are closed by purse-string suture, or invaginating suture, or one or both ends are brought to the skin surface _ while the divided ends of the main intestinal tract are united by some form of entero-anastomosis (either end-to-end or side-to-side, after closing the ends) _ as shown in Figs. 3971–3978. and in Fig. 3968.

It is true that in every case where lateral entero-anastomosis is performed, without the excision of the intervening loop, a certain degree of functional exclusion occurs in the isolated loop, in that only a small part of the usual intestinal contents probably pass through that portion of the bowel (Fig. 3979) _ yet the sense in which intestinal exclusion or occlusion is used in the present description, is meant to be limited to those cases in which the excluded part of the intestinal tract is completely cut off, and shut off from the rest of the intestinal canal, no longer transmitting feces, and where at least one end of the excluded portion is usually made to open upon the surface.

While the completely (bilaterally) excluded portion of the bowel has sometimes been left *in situ* after closing its ends _ without any connection with the rest of the intestinal tract whatever, and with no connection with the skin surface, without untoward results _ yet the majority of Surgeons disapprove this plan, and advise having at least one end of the excluded portion in connection either with some patulous portion of the intestinal canal, or a hollow viscus, or with the surface of the body _ to avoid the dangers which are apt to arise from an abnormally shut-off cavity potential of infection and of cystic distention.

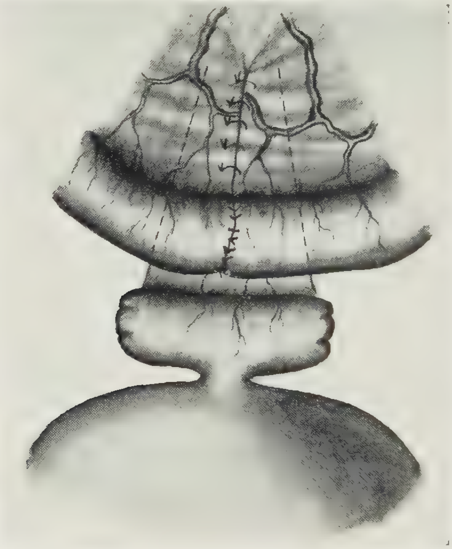


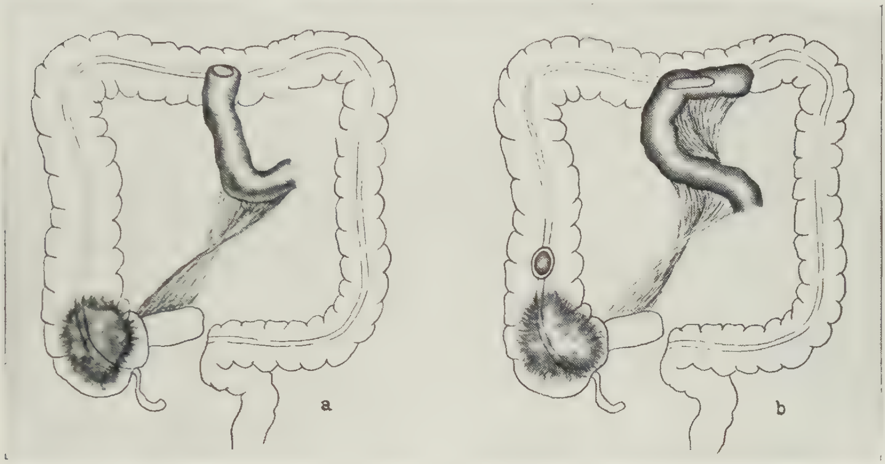
Fig. 3968.—Illustration of total or bilateral exclusion of a portion of the bowel. A part of the lower ileum, with its mesentery, has been removed, in the case of an otherwise inoperable intestinovesical fistula _ followed by closure of the ends of the excluded portion of ileum _ and by an end-to-end ileo-ileostomy, between the ends of the main part of the ileum. An illustration of partial or unilateral intestinal exclusion is seen in Figs. 3969 and 3970.

In complete exclusion, with anchorage of one end of the loop to the skin, the amount of discharge is insignificant after the first few days.

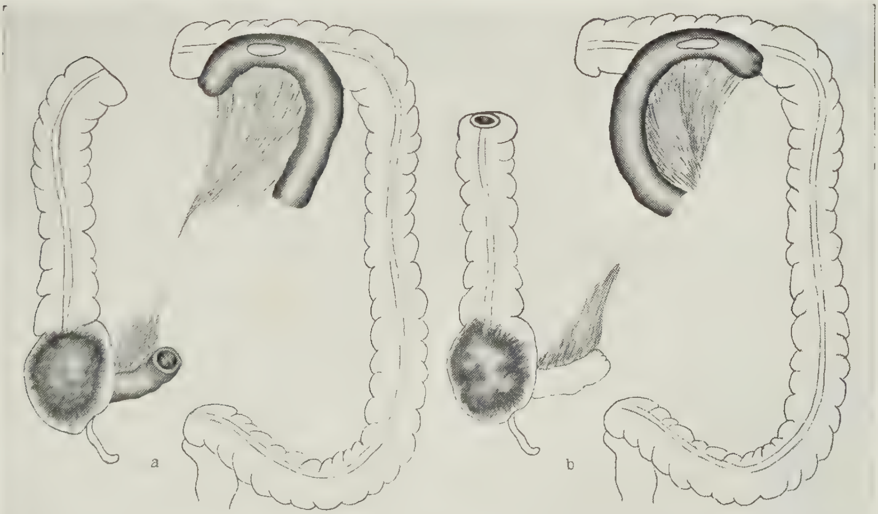
As many as 13 feet of small intestine have been successfully short-circuited _ though the length of the short-circuited portion is usually measured by inches rather than feet.

"Intestinal occlusion" should only be employed when the continuity of the intestine is interrupted by section of the bowel in one or in two places.

Simple lateral entero-anastomosis does not take the place of intestinal exclusion, and has largely been replaced by the latter _ for the reason that, in the former, the intestinal current is not wholly diverted, a part still continuing to pass by the old route, the mere presence of which or the overloading of which may be undesirable — coupled with the fact that the new intestinal opening tends to contract as long as the old route functionates to any extent.



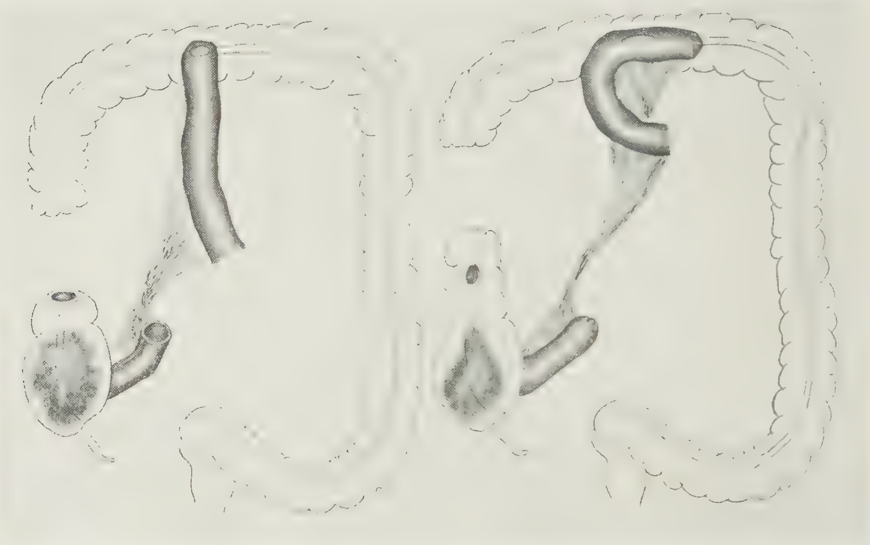
Figs. 3969 and 3970.—UNILATERAL INTESTINAL EXCLUSION: — **a**, Unilateral exclusion of the ileum, with end-to-side ileocolostomy; — **b**, unilateral exclusion of the ileum with side-to-side ileocolostomy, and with cecostomy. (Figs. 3969–3978 modified from Schmieden.)



Figs. 3971 and 3972.—BILATERAL INTESTINAL EXCLUSION: — **a**, Bilateral exclusion of the lower part of the ileum, cecum, and ascending colon, with side-to-side ileocolostomy, and with ileostomy; — **b**, bilateral exclusion of the lower part of the ileum, cecum, and ascending colon, with side-to-side ileocolostomy, and with colostomy of the ascending colon.

Anastomosis between the ileum and colon is the entero-anastomosis most frequently performed in this connection.

Indications for Intestinal Exclusion.—Localized tuberculosis of the bowel; _ Inoperable carcinoma, especially of the cecal region; _ Intestinal fistulæ, especially of the pyostercoraceous type; _ Marked cases of colitis; _ Intestinovesical and intestinovaginal fistulæ; _ Usage of an excluded portion of the intestine to replace or repair the bladder; _ Usage of the same to form a communication between the stomach and the skin (Tavel's jejunogastrostomy); _ Usage of the same to replace or repair the esophagus (Roux's operation); _ Usage of the same to replace a portion of the large intestine; _ Idiopathic dilatation of the large intestine, with obstipation; _ Congenital hypertrophy of the colon; _ As a preliminary measure preceding partial enterectomy instead of a preliminary colostomy; _ As a preliminary to operating to close a fecal fistula or artificial anus; _ Gangrenous herniæ, where a lateral entero-anastomosis is performed at the base of the loop, preliminarily to the later treatment of the loop (Roux's operation); _ As a lateral jejunojejunostomy, accompanying gastro-enterostomy (the last two are illustrations of lateral entero-anastomosis); _ Chronic intestinal invagination; _ Simple ulceration of the intestine.



Figs. 3973 and 3974.—Bilateral Intestinal Exclusion: _ **a,** Bilateral exclusion of the lower part of the ileum and of the cecum, with end-to-side ileocolostomy, and with both ileostomy and cecostomy; _ **b,** bilateral exclusion of the lower part of the ileum and lower half of the ascending colon, with side-to-side ileocolostomy, and with colostomy of the ascending colon.

Chief Methods of Unilateral and Bilateral Intestinal Exclusion.—The main methods of accomplishing partial and complete intestinal exclusion, of which many combinations are possible, are classified, according to Moynihan, as follows:

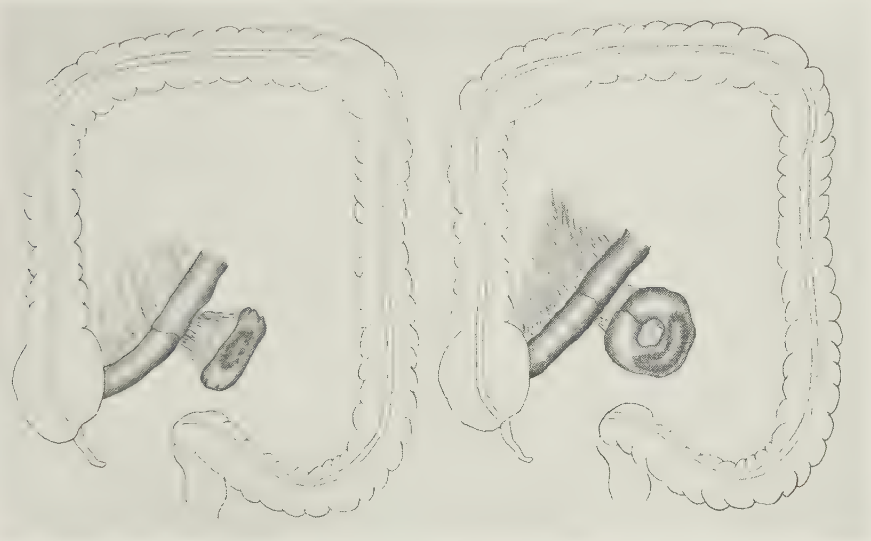
(1) Partial Exclusion:
- (*a*) Entero-anastomosis of Maissoneuve.
- (*b*) Entero-anastomosis, with suture-constriction of the part of the bowel distal to the upper opening.

(2) Complete Exclusion:

(*a*) Unilateral Exclusion _ where the intestine is severed, after which the proximal end is implanted into the lateral aspect of the distal _ the distal end being either closed or anastomosed with the skin.

(*b*) Bilateral Exclusion _ where the intestine is severed at two sites, after which the main intestinal channel is restored, and the excluded loop of bowel is left detached from the main intestinal circuit. The excluded loop is then dealt with in one of several ways: _ One end of the loop is closed, and the other anastomosed with a segment of bowel, _ One end is closed, and the other anastomosed with the skin, _ Both ends are anastomosed with the skin, _ Both ends may be closed if a fistula be present in the bowel between them, _ Or both ends may be anastomosed with a segment of bowel into which the intervening loop will drain.

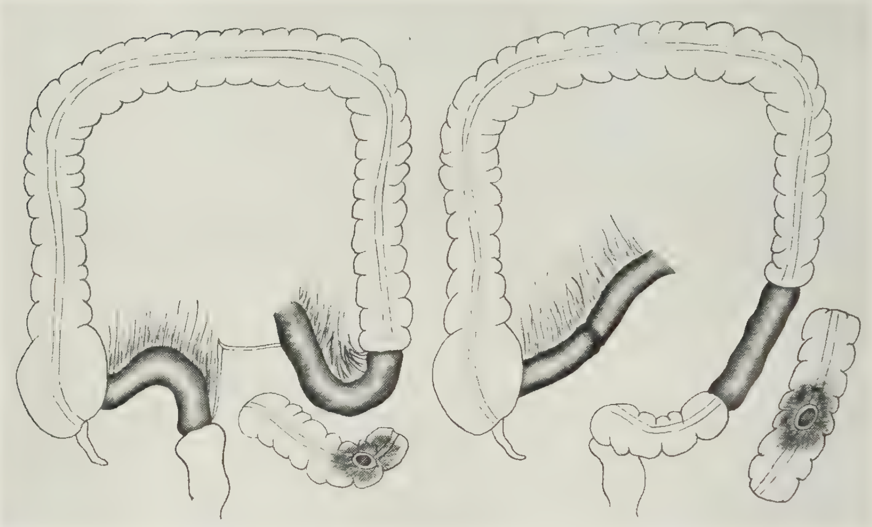
The main features of these different procedures will be given _ and are pictured in Figs. 3969–3978.



Figs. 3975 and 3976.—Bilateral Intestinal Exclusion: _ **a**, Bilateral exclusion of a portion of the ileum near the cecum, with end-to-end ileo-ileostomy, and with closure of both ends of the excluded portion of the ileum; _ **b**, bilateral exclusion of a portion of the ileum near the cecum, with end-to-end ileo-ileostomy, and with end-to-end union of the two ends of the excluded portion of the ileum.

Partial Intestinal Exclusion by Lateral Entero-anastomosis.—Partial exclusion is a feature of all forms of lateral intestinal anastomoses brought about without first excising a part of the intestine _ and, as these have been fully described and illustrated (pp. 757–766), their details will not be recounted here. (If a segment of intestine be excised _ or isolated, along with its mesentery, without excision _ and the ends of the main intestine be anastomosed _ the operation becomes a total rather than partial exclusion of the eliminated part). Isoperistalsis should be observed as a part of the technic.

Partial Intestinal Exclusion by Combined Ligature-and-suture Constriction of the Proximal Limb of the Bowel Just Distal to a Lateral Entero-anastomosis.—This technic is made plain, diagrammatically, in Fig. 3979 _ where it is seen that nothing more passes through the proximal limb of the partially excluded loop, laterally anastomosed at its base, but mere drainage.



Figs. 3977 and 3978.—Bilateral Intestinal Exclusion:—**a,** Bilateral exclusion of the lower part of the descending colon and sigmoid colon—with division of the lower part of the ileum, followed by end-to-end ileocolostomy between the proximal end of the ileum and the lower end of the descending colon, and by end-to-end ileorectostomy between the distal end of the ileum and the upper end of the sigmoid—and with colostomy of the excluded colon;—**b,** bilateral exclusion of the lower part of the descending colon and adjacent sigmoid colon—with isolation of a loop of the ileum, near the cecum, and its interpolation, between the ends of the descending and sigmoid colon, forming end-to-end ileocolostomy and ileosigmoidostomy—followed by end-to-end ileo-ileostomy between the ends of the ileum from which the interpolated portion of ileum, with its mesentery, was isolated—and by colostomy of the excluded portion of descending and sigmoid colon.

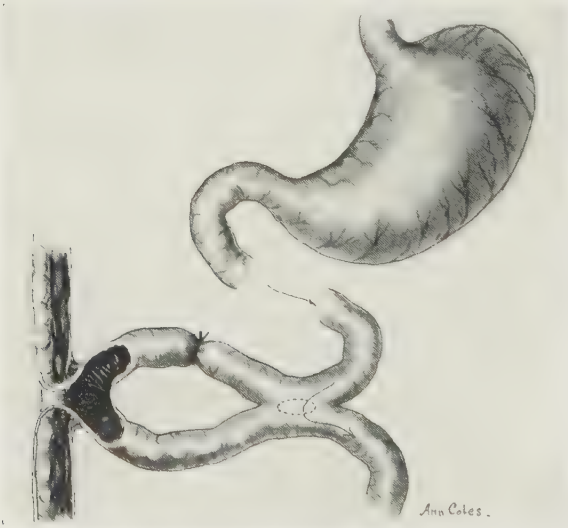
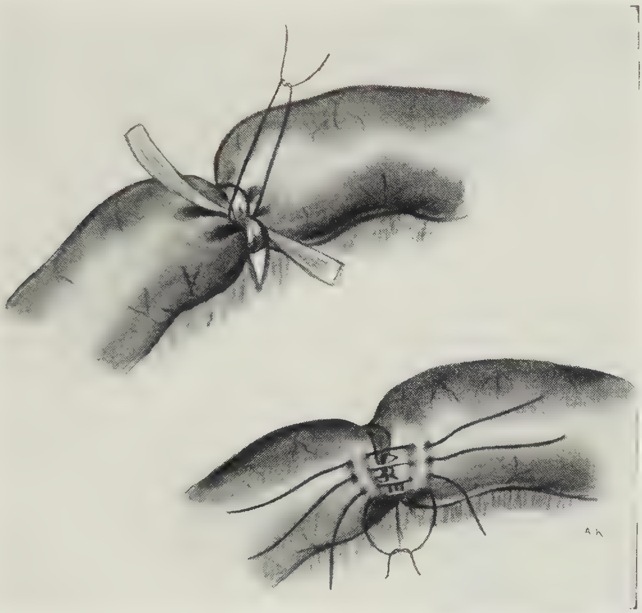


Fig. 3979.—Partial Intestinal Exclusion, in the Case of a Fecal Fistula, by Combined Ligature and Suture Constriction of the Proximal Limb of the Bowel, just Distal to a Lateral Entero-anastomosis

In Bogoljuboff's technic a slender flat strip of aponeurosis, taken from the abdominal wall in the course of the operation, is passed through an opening made in the mesentery, and is then tied around the intestine tightly enough to produce the degree of stenosing or narrowing which may be desired (Figs. 3980 and 3981). To make sure that this knotted aponeurotic strip will not slip, a piece of silk is included in the first phase of the aponeurotic knot, and is then, itself, tied over the second phase. Finally, the opposite adjacent aspects of the intestine are sutured together with Lembert stitches over the site of stenosing ligature. This artificial stenosing of the intestine in its continuity was originally accomplished by silk ligature _ but silk was found to cut its way into the intestinal lumen, the lumen being soon restored, and necrosis sometimes occurring.



Figs. 3980 and 3981.—Partial Intestinal Exclusion, or Stenosing, by Means of Combined Ligature-and-suture Constriction _ (Bogoljuboff): _ a, A strip of aponeurosis from the abdominal wall is passed through an opening of the mesentery and tied around the intestine sufficiently closely to produce the desired degree of narrowing of the lumen, the aponeurotic knot being reinforced by a silk knot to prevent slipping; _ b, circular suturing, with Lembert stitches, of the two aspects of the intestine immediately adjacent to the ligature, over the aponeurotic band, thus further turning in and reinforcing the site of stenosis.

Partial intestinal exclusion is sometimes accomplished by double bending and suturing of the loop of the intestine (Fig. 3982). The sutures are of catgut _ and a patulous lumen is eventually restored.

Complete Intestinal Exclusion by the Unilateral Method.—In the usual type of this technic, briefly stated, following the single division of the intestine, the distal end of the divided bowel is closed, and the proximal end is anastomosed with the main intestine above (proximal to) the division (Fig. 3969, a).

The abdomen is preferably opened in the median line _ and through healthy skin. Adhesions are often encountered, especially in the category of cases in which intestinal exclusion is performed _ and are to be dealt with as indicated in the particular case. It is of paramount importance that the relations of the loops of the intestine in the field of operation be definitely recognized — which, also, is sometimes not easy in these cases. A mistake in the parts of the intestinal canal would be awkward — and might be serious.

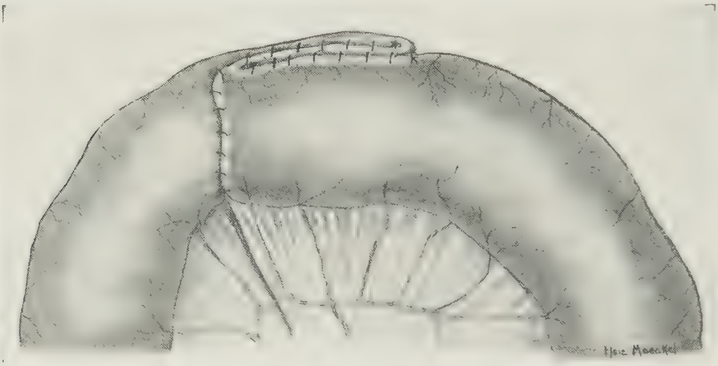


Fig. 3982.—Partial Intestinal Exclusion by Means of Double Bending and Suturing of the Intestinal Loop.

In working in the lower abdomen and pelvis the cecum is the rallying point. Isoperistalsis should be observed in making the intestinal joinings. The proximal and distal limits of the specific tract to be operated upon should be definitely recognized.

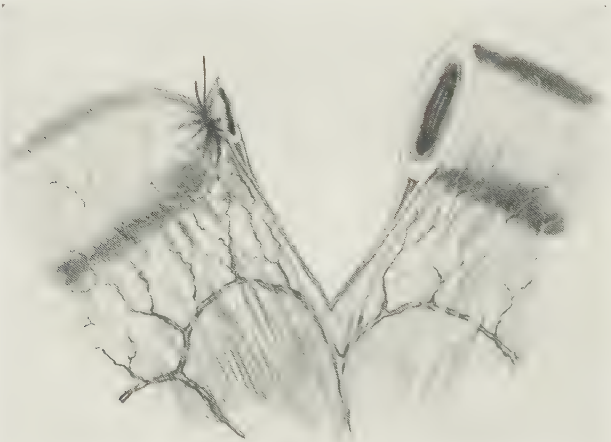


Fig. 3983.—Crushing, Ligating, and Dividing the Intestine in Unilateral Intestinal Exclusion; — The distal end has simply been ligated — after which it will be invaginated, as will be the proximal end — these steps being preparatory to anastomosing the proximal end, by lateral anastomosis, with the main intestine above. Preliminary crushing is not here shown.

The method of making the entero-anastomosis must be determined. If an end-to-end or an end-to-side anastomosis is to be made, the intestine is doubly clamped, and divided between. When the small intestine is to be anastomosed with the large, however — and this is usually the case in these instances — the best method is to unite the closed end of the small intestine laterally, and isoperistaltically, with the large intestine (v. Fig. 3970, **b**). In carrying out this technic it is well to crush the intestine to be divided with an enterotribe _ over a width sufficient to admit of ligating the crushed part of each end with silk (Fig. 3983). These intestinal ends are then inverted by means of one or two tiers of purse-string suture through the outer coats, or by one or two tiers of Lembert stitches. The closed distal end is dropped back into the cavity _ while the closed proximal end is anastomosed, peristaltically, with the colon. The details of the entero-anastomosis are precisely the same as those employed in the ordinary types of entero-anastomosis.

Whether the excluded portion of intestine, or the distal end of the divided intestine (under which circumstances it will not have been closed), is to be anastomosed with the skin, will be determined by the special conditions and the Surgeon's judgment _ see Comments. The abdomen, otherwise, is closed as usual.

Complete Intestinal Exclusion by the Bilateral Method.—In the usual type of this technic, stated briefly, following the double division of the intestine, proximally and distally, the proximal end of the upper intestinal segment is anastomosed with the distal end of the lower intestinal segment _ while one end of the excluded segment is closed, and the other end is anastomosed with some part of the intestinal canal or with the skin. Sometimes both ends are brought to the skin.

In this method of excluding a portion of the intestine two complete transverse divisions of the intestine are made instead of one, as in the unilateral operation _ but the divisions are here made exactly as described in the preceding form of exclusion _ preferably after crushing with the enterotribe, ligating, and inversion _ whether it be of the small or large intestine. In the bilateral operation one end, at least, of the excluded loop of intestine must be left, and be anastomosed with some part of the intestinal canal or with the skin _ which, by preference, should be the distal end (the peristaltic waves thus aiding in the emptying of the excluded part).

Here, as in the unilateral operation, the details of planning the main intestinal anastomosis and the drainage anastomosis are matters to be decided by the individual case and by the Surgeon.

The technical details of the intestinal sections, and of the main and secondary anastomoses, are the same as those employed in accomplishing these ends for other than purposes of intestinal exclusion.

Comments.—Summarizing the field of usefulness of intestinal exclusion, Kocher concludes, _ "One of the most important operations in intestinal surgery, and one which has even a more extensive field of usefulness than Woelfler's gastro-enterostomy, consists in uniting two portions of intestine so that the contents of the upper will empty into the lower without passing through the intermediate or short-circuited loop." Moynihan writes, _ "From what has been said it will be recognized that unilateral exclusion, save in diseases affecting the lower end of the ileum, offers no advantages over lateral anastomosis; _ and that bilateral exclusion affords the best means of dealing with certain diseases, chiefly tuberculous and malignant, in the cecum and colon, and with fistulæ between the small intestine and the bladder or vagina."

There is a tendency for the simpler methods of intestinal exclusion to lead one away from radical excision _ which should be borne in mind where serious considerations of the patient's ultimate welfare hangs in the balance.

In bilateral exclusion it is considered unwise to close both ends of the excluded loop without making some provision for its drainage.

In unilateral exclusion of parts of the small intestine the excluded loop generally continues to contain fecal matter _ so that a fistula from it continues to discharge, as does also its proximal end, if anastomosed with the skin. In unilateral exclusion of part of the large intestine, however, the condition is somewhat different _ so that if the ileum be severed near its lower end, and its proximal end be anastomosed with the ascending colon, there will be some backward flow, as occurs from the ileocecal valve, but the lower end of the ileum will remain empty. If the proximal end of the ileum be anastomosed with the sigmoid, at first there will occur little or no backward flow along the descending and transverse colon _ but, later, some fecal matter may flow backward toward the cecum (Moynihan).

Intestinal exclusion may often be regarded as an alternative method of saving from the irritation, caused by its functionation, a part of the intestine which it is not necessary, or safe, to excise.

The chief reason why a simple lateral entero-anastomosis will often fail, while an intestinal exclusion will succeed, is that an artificial opening tends to grow smaller if it conveys only part of the intestinal flow.

Ileocolostomy or ileosigmoidostomy is preferable to any form of colocolostomy _ owing to the relative immobility of the large intestine and its limited peristalsis.

Unilateral exclusion is more frequently used than is simple lateral anastomosis.

In unilateral exclusion, intestinal contents, including gas, tend to accumulate in the excluded part.

OPERATIONS FOR INTESTINAL OBSTRUCTION

Two urgent indications are present in intestinal obstruction _ the one of primary importance being to relieve the obstruction immediately upon its recognition _ the one of very next importance to correct the cause of the obstruction.

The necessity of the first of these, and the desirability of the second, are self-evident _ and equally so is the fact that removal of the cause of obstruction is not always possible, either from the nature of the obstruction, or the condition of the patient, and that in such cases some compromise measure must be adopted, meant to be either a temporary or permanent means of providing exit for the intestinal contents.

Fortunately, the majority of the causes of obstruction are, in themselves, removable _ and, provided the patient's condition permit, should be removed at the one operation _ so that both the obstruction and its cause are rectified at the one sitting. If the cause be removable, but the patient's state contraindicate at the immediate time any attempt to remove it, after relieving its result, the obstruction _ then no alternative exists but to accept the compromise _ secure the patient's life at once _ and remove the defect later.

Causes of Intestinal Obstruction:

Intestinal paresis, from infective peritonitis or toxemia.
Symptomatic obstruction, of reflex origin, due to injury or disease.
Volvulus of small or large intestine.
Intussusception.
Stricture of the bowel.
Fecal impaction.
Adherent appendix vermiformis.
Adherent Meckel's diverticulum.
Intraperitoneal adhesions.

Intestinal strangulation by unnatural openings in the mesentery.
Arterial mesenteric embolism.
Venous mesenteric thrombosis.
Torsion of the omentum.
Intestinal strangulation by unnatural openings in the omentum.
Herniæ into retroperitoneal pouches.
Intestinal strangulation by the fallopian tubes.
Intestinal strangulation by the elongated pedicle of an ovarian cyst.
Intestinal strangulation in unnatural openings in the broad ligament.
Obstruction by intestinal, or by biliary calculi.

From the above list, which might be further added to, it will be understood what is meant by observing that immediately next to relieving the obstruction and furnishing an intestinal outlet, comes the correction of the defect upon which the obstruction depends, and, in some cases, through which it might recur _ and, further, how varied are the causes which may occasion obstruction of the bowel.

Operations for Intestinal Obstruction.—Operations for obstruction of the bowels are undertaken, as may be inferred from what has been said, and from a review of its many causes, with a twofold object _ first, relief of obstruction _ and, second, correction of cause. It is of especial interest to note that out of the long list of causes of obstruction given, that in but a single instance is the relief of the obstruction followed by correction of the cause _ in obstruction from fecal impaction _ and even in this instance it might be said that the fecal impaction is, that is, constitutes, the obstruction. In quite marked contrast with this, on the other hand, it is quite plain that after opening the abdomen no operation for obstruction, *per se*, is ever called for at all in many instances (in actually the majority) _ but that simply the correction of the cause of the obstruction is immediately followed by not only the immediate relief of the obstruction but also of any likelihood of its recurrence _ as, for instance, in volvulus, intussusception, adherent vermiform appendix, adherent Meckel's diverticulum, intraperitoneal adhesions, strangulation of the bowel by unnatural mesenteric and omental openings, torsion of the omentum, herniæ into retroperitoneal pouches, strangulation of the bowel by the fallopian tubes, or by the pedicle of an ovarian cyst, and strangulation of the bowel by abnormal openings in the broad ligaments.

The Surgeon is concerned not only with the relief of the positive obstruction _ the actual intestinal blockage _ but he is concerned even more immediately, and more imperatively, with the results of that blockage _ with the septic absorption from an obstructed bowel _ and also from possibly a partially necrotic bowel. From this it will be seen that it is not sufficient simply to remove the cause which has brought about the obstruction _ but that it is incumbent upon the Surgeon, as even a more imperative duty, to see that the bowel is emptied of its obstructing contents, even if he be fortunate enough to remove its cause. It does not necessarily follow that because the source of obstruction is relieved that the intestinal contents will, as an invariable consequence, flow past the site that was obstructed, and on out through the rectum _ for example, a bowel may be left so paretic following the removal of the cause of some obstruction as to be unable to functionate _ so that, in such cases, the Surgeon may have to act, as far as the bowel itself is concerned, exactly as though he had not been able to remove the original source of obstruction.

From what has been said it will be seen that very extreme conditions may have to be dealt with _ very simple, or very complex in nature, as they may prove.

Operation for Intestinal Obstruction by the Operative Removal of the Cause of the Obstruction.—Guidance for the operative technic will here be taken from the structure involved as the cause of the obstruction, from the condition of the bowel obstructed, and the nature of the obstruction. The operative technic becomes that of exposing and dealing with the special structure which is responsible for the blockage _ and will be found, in many instances, sufficiently covered under the surgery of the various structures mentioned under the heading of Causes of Intestinal Obstruction, upon the preceding page.

It is to be emphasized, in operating in this category of cases, that if the removal of the cause does not reasonably promise to be followed by the flow of intestinal contents past the site of obstruction, and throughout the rest of the intestinal tract, that the case then becomes, additionally, for all practical intents and purposes, one of the following category, and must be dealt with accordingly, in so far as the relief of the obstruction itself is concerned _ except that it will be better off than those of the class in which no attempt can be made to relieve the cause, for the cause of the trouble will have been removed even if the result of the trouble is still to be dealt with.

Operation for Intestinal Obstruction by the Operative Relief of the Obstruction Itself, Without Any Attempt to Immediately Remove Its Cause.—One of three courses is here open to the Operator: _ (*a*) Combined partial enterectomy, with accompanying entero-enterostomy, _ (*b*) Simple enterostomy, _ (*c*) Mikulicz's double-stage operation (anchorage of the obstructed intestinal loop outside of the abdomen, with the performance of partial enterectomy and enterostomy the following day). All efforts to remove the cause of the obstruction, and to make its recurrence unlikely, are left until a subsequent time _ the patients upon whom this course of procedure is carried out usually being *in extremis*.

Preparation for Operation.—No elaborate preparation is ordinarily possible in this class of cases _ owing to the lack of time and the condition of the patient. No preliminary preparation at all, or but a modified one, is possible in many cases. It is especially desirable to wash out the stomach before the patient goes upon the table. If circumstances permit, the abdominal skin should receive some degree of preliminary preparation _ and final preparation upon the table. His body should be kept warm by ample clothing, over other than the field of operation, and free from wetting. The room should be kept no lower than 70° F. Provision should be at hand for artificially warming the patient _ and an ample supply of towels wrung out of hot normal saline solution should be at hand for protecting coils of eviscerated intestines. A combination of ether and chloroform is preferred by many in these cases _ and analgesia is sometimes employed where a simple enterostomy is to be performed upon a patient in bad condition. Reasonable expedition should be observed throughout the operation. Unquestionably much the larger part of the mortality, which is usually in the neighborhood of 50 per cent., is not due to the condition of obstruction or to the operation, nor to both combined _ but to delay.

Operation to Relieve the Obstruction Itself.—With the patient in the Trendelenburg position, the abdomen is opened by a median incision _ unless there be some special indication for a differently placed incision. If a second incision be indicated, after opening the abdomen, this may be made. The opening should afford room for expeditious and untrammeled working. A paramedian incision, with temporary displacement of the rectus, is preferred by some _ but does not give as much freedom for manipulation. On opening the peritoneal cavity provision should be made to guard against the gushing out of the intestines, which is apt to otherwise take place under much distention.

Once within the abdomen, search should be made for the site of obstruction if the condition of the patient permit this – and this search should be carried out systematically and not by random – and, to one accustomed to such investigations, it can be carried out expeditiously. If two or three fingers are unable to accomplish this, the entire gloved hand should be introduced. Each Operator will have worked out his own routine in conducting this examination for the obstructed bowel. The cecum constitutes a good rallying point, having a fixed position. If it be distended, the obstruction is somewhere in the large intestine, which should then be systematically examined. If the cecum be collapsed, the obstruction is in the small intestine. As the obstructed coil is usually found in the pelvis, whether it be of the small or large intestine, it is well to begin the search in the pelvis – but if this be negative, one may begin at the commencement of the jejunum – and pass each loop of the small intestine through his fingers, and back into the abdomen until he reaches the cecum again. Finally, all the potential hernial openings are examined. Special conditions before the operation, or after the abdomen is opened, may point to certain definite localities as being likely to harbor the obstructed loop. Sometimes the first empty coil of small intestine is taken – and this is followed upward until the blockage is encountered. Sometimes the coils of intestine are allowed to escape, in review, out into hot towels, before the eyes and hands of the Surgeon (Kuemmel). Owing to the fact that the large intestine is sometimes distended distally to the obstruction, a colostomy has been performed on the wrong side of (distal to) the blockage.

It will sometimes happen that satisfactory progress cannot be made in determining the site of obstruction, and the conditions present, owing to the great amount of distention. In such instances it is often well to evacuate the gaseous and fluid contents of the distended intestine by enterotomy, or special form of puncture and evacuation by means of a long glass tube, with rubber tube attachment (Moynihan), as previously described and pictured (v. p. 631). Following evacuation the enterotomy or puncture wound is sutured – and the further steps of the operation decided upon – even to the extent of remedying the cause of the obstruction, if all be propitious to that end.

In the category of desperate cases, undertaken at the time solely to relieve the obstruction, no attempt is made, at least at this time, to do more than provide for the escape of intestinal contents proximal to the site of blockage – with no effort to relieve the cause of that blockage – but only the quickest and simplest relief is sought for the paramount indication, the obstructed intestinal flow and its resultant toxemia. These are cases in which no effort is made to remove the producing cause of obstruction because of unfitness of the patient to stand any such procedure. But there may also occur cases in which no attempt is made to correct the cause of blockage not because of the patient's general condition, but because the cause of obstruction itself is not considered removable. So that in both of these classes of cases it becomes equally, although from different reasons, simply a question of making provision for the relief of the obstruction. In the cases in which the patient's general condition causes this line of action, the abdomen is opened by a limited incision, and no attempt is made to examine the intraperitoneal region. Through the small opening made a coil of intestine will generally tend to protrude – and experience has amply shown that this loop of bowel is usually the wisest one to select for the channel of evacuation, even though chosen at random — subsequent operation so often showing that a better coil could not have been selected, even though the abdomen had been widely open. The most satisfactory method of immediate relief, after making full provision to prevent soiling, is to incise the loop of intestine and insert a flanged glass tube (to the outer end of which a rubber tube has been attached) into the lumen of each limb of bowel, the walls of which are then tied around the tube by the purse-string suture inserted into the walls of the intestine before making the incision. Sometimes the convexity of the loop is anchored in the margins of the abdominal wound with the peritoneum sutured everywhere about it — and, after two or three hours (or longer if possible), opened within an area safeguarded by a purse-string suture, which then ties the intestinal wall around the flange of the inserted tube.

Mikulicz's double-stage operation consists in anchoring the obstructed loop in the abdominal wound so that the loop itself projects outside of the abdomen — and, after a day, excising the two limbs of the loop, and tying a glass tube in each limb.

When circumstances admit such a deliberate procedure, the most ideal method, in the particular case, may consist in excising the involved part of intestine, embracing the obstructed site, and then performnig an entero-enterostomy between the severed ends.

The abdominal wound is treated as indicated in the special case.

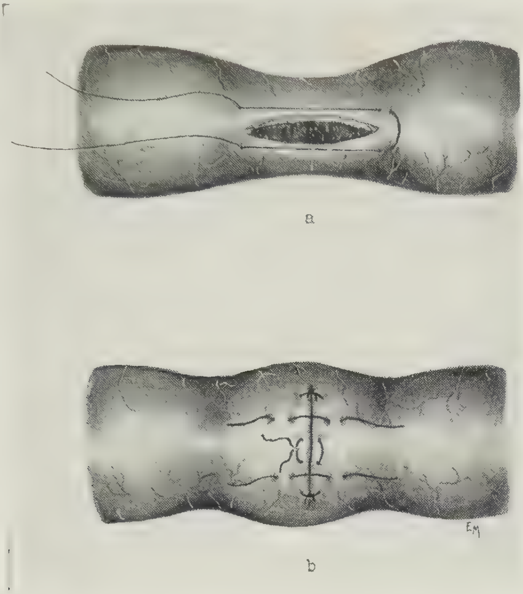
OPERATIONS FOR INTESTINAL STRICTURE

Description.—Stenoses of the intestinal canal may be congenital or acquired — the treatment for the two classes of stricture being different.

Operation for Congenital Intestinal Stenosis.—These, in order of frequency, are usually jejuno-ileal, duodenal, and colic — and may be single or multiple. If the condition of the patient permit, the ideal operation is a partial enterectomy followed by entero-enterostomy — except when the stricture is in the duodenum, when a gastrojejunostomy is indicated — unless, in the case of a low duodenal stricture, a duodenojejunostomy can be performed through the transverse mesocolon. If the stricture be one low down in the intestine, an enterostomy below the stenosis, for nourishment, may be the only measure that can be immediately carried out in some of these young, weak, unfavorable cases — to be followed, when the condition is better, by an entero-enterostomy.

Operation for Acquired Intestinal Stenosis.—In cases where more than one-half of the intestinal lumen is gone, or where marked adhesions or distortion are present as complications, either a partial enterectomy, followed by entero-enterostomy, or a lateral entero-anastomosis, are the measures to be considered. Sometimes, in a bad condition of the patient, the only immediate recourse is a temporary enterostomy — to be subsequently followed by a radical operation.

Enteroplasty for Acquired Intestinal Stricture — Makins' Technic.—This is an ideal procedure provided the stenosis be of limited extent, and one-half, at least, of the intestinal lumen be present. Makins applies the principle of enteroplasty (the same, in general respects, with pyloroplasty, by the same technic), in the following way: He first surrounds the site to be incised by an elongated, penetrating mattress-suture of silk, placed axially (Fig. 3984, **a**). When this is drawn loosely and tied, the two angles of the former wound are brought together in the center of the now transversely drawn wound (Fig. 3985, **b**). Interrupted marginal sutures are now carried transversely through all the coats. The temporary coaptation suture is then removed—and the first line of through-and-through sutures is buried by a second line of Lembert stitches.



Figs. 3984 and 3985.—Enteroplasty for Acquired Intestinal Stricture—Makins' Method:—a, Placing of the outlying elongated, axial, penetrating mattress-suture, and incising the bed of the stricture;—b, the loosely tied, temporary mattress-suture, converting the former ends of the incision into the, now, centers of the wound—also showing some of the through-and-through marginal sutures and overlying Lemberts.

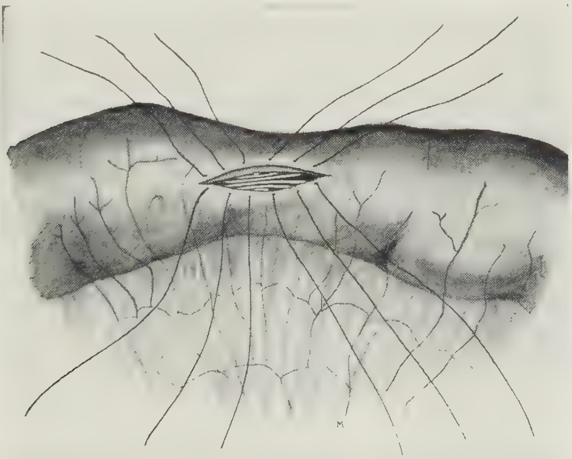


Fig. 3986.—Enteroplasty by the Heinecke-Mickulicz Method for Acquired Intestinal Stenosis—I;—The axial incision through the strictured site—and the placing of the axially running sutures.

Enteroplasty for Acquired Intestinal Stricture as Usually Applied.—Instead of applying the principle of enteroplasty in the above manner, the more usual way may be used. After making the axial incision through the strictured wall, the center of the lip of the wound, on each side, is drawn lateralward, either by small wound hooks or by traction sutures placed through the outer coats (Fig. 3986. While the original axial wound is thus held, so as to be now transverse, a first tier of through-and-through marginal sutures is applied _ and a subsequent tier of burying in Lemberts (Fig. 3987).

Comments.—Other methods, in cases of acquired stenosis, of increasing the caliber of the narrowed portion of intestine are employed in connection with operations of resection: _ Jeannel, after partial enterectomy, cuts the ends of both pieces of intestine obliquely from above downward (the right-hand piece from right to left, and the left-hand piece from left to right) _ and then unites their edges by suturing _ forming an "elbow," as in the junction of pieces of stove-pipe. Chaput, after performing partial enterectomy, united the ends of the bowels by circular suturing _ then made a longitudinal incision through the walls of the united intestines opposite the mesentery and sutured this longitudinal division transversely _ employing, in the latter part of the operation, the principle of the usual enteroplastic operation. Chaput, by another method, completely divides the bowel obliquely from above downward and from side to side _ forming two oblique ellipses of the same size, but in opposite directions, at the ends of the intestines _ followed by union of the intestinal margins.

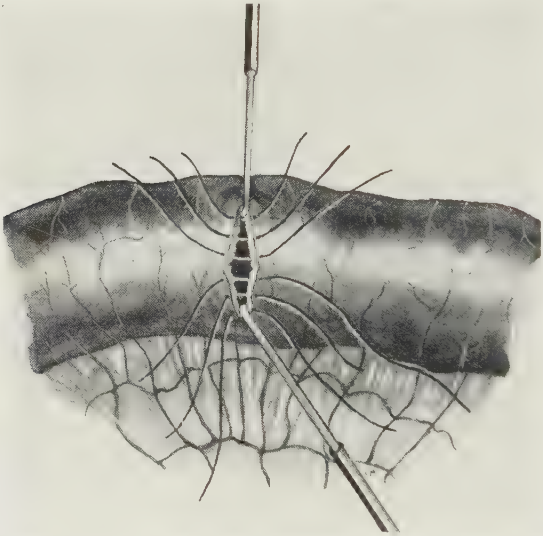


Fig. 3987.—The Same _ II; _ The axial incision tensed transversely _ thereby widening the narrowed bowel. When the axially placed sutures, which now cross the new direction of the wound transversely, are tied, this first through-and-through marginal row is reinforced by a row of Lembert stitches.

OPERATIVE TREATMENT OF INTUSSUSCEPTION

Description.—Intussusception of the ending of the ileum into the cecum occurs very much more frequently than other forms of intussusception (almost as frequently as of all the other varieties combined) _ next most frequently, of one part of the small intestine into an adjacent part of the small intestine _ next, of the ileum into the colon _ and of one part of the colon into another part of the colon. The condition is very much more frequent in very young children _ a very large proportion of the cases occurring under one year of age. The following surgical measures for the relief of intussusception are available:

Manual Disinvagination.—(*a*) Manual Disinvagination of the Exposed Intussusception should always be first reasonably tried, usually through a subumbilical median abdominal section. The maneuver should be gently carried out _ and is suggested in Fig. 3988. Having exposed the full extent of the intussusception (and the limb of ileum which has been invaginated into the cecum, may continue through the ascending colon, transverse colon, until its most advanced end may be found in the descending colon), the Surgeon uses the fingers of one hand (dependent upon the site of the invagination), approximated about the intussuscipiens, to gently press the end of the intussusceptum backward along the intussusceptum _ advancing his hand with each little progress that may be recognized. The opposite hand steadies the

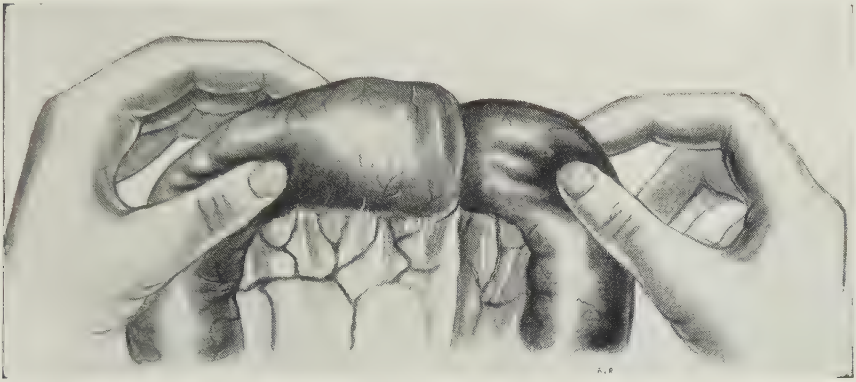


Fig. 3988.—Manual Disinvagination of the Intussuscepted Bowel.

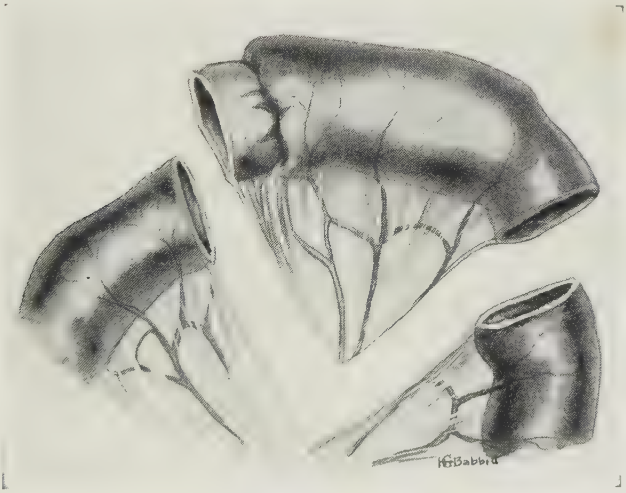
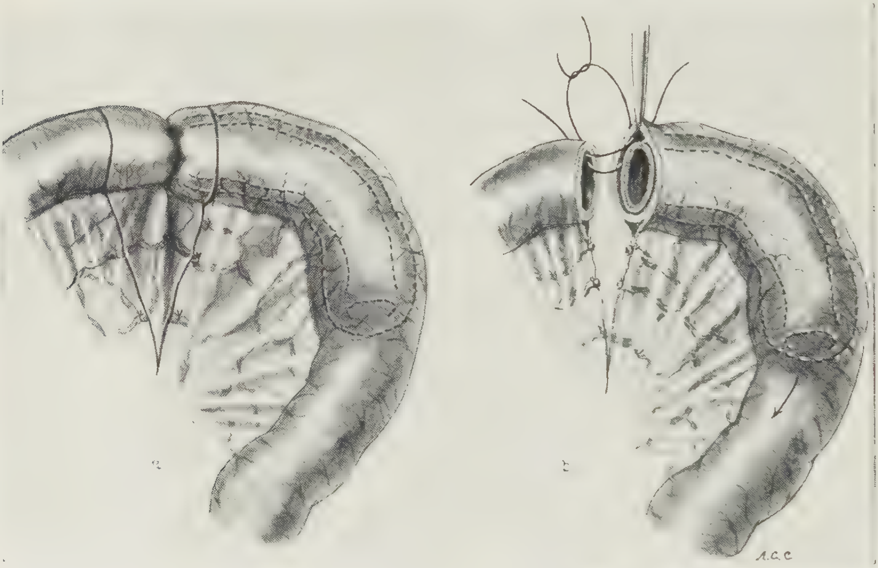


Fig. 3989.—Partial Enterectomy of the Entire Site of Intussusception Followed by End-to-end or End-to-side Entero-enterostomy.

intussuscipiens along which the intussusceptum is traveling backward, to become disengaged _ if the intussusception be of any considerable extent. If the intussusception be very limited (and in those cases in which a very long intussusception has been nearly delivered), the Surgeon's hand which has been steadying the parts, against the fingers which have been pushing the intussusceptum backward, now takes its place upon the free portion of the intussusceptum, just proximal to the intussuscipiens, and practices very gentle tension _ scarcely more than enough to direct the intussusceptum outward, in aid of the hand which is pushing it outward. If reasonable efforts in these directions fail, further similar attempts should be abandoned. Under such circumstances one of the following measures may be adopted:

Partial Enterectomy of the Entire Site of Invagination, Followed by End-to-end or End-to-side Entero-enterostomy.—This method is indicated in Fig. 3989 _ and is accomplished as is an ordinary partial enterectomy



Figs. 3990 and 3991.—Partial Enterectomy of the Base of the Intusssusception, Followed by End-to-end Entero-enterostomy, Leaving the Isolated and Movable Intussusceptum to Be Passed by Rectum _ Oderfeld's Technic: _ **a**, The lines indicating the base of the intussusception to be excised; _ **b**, the base of the intussusception, and corresponding mesentery, have been excised _ and the freed intussusceptum is passing on down the distal limb. The intestinal anastomosis will be performed in the usual manner.

(v. p. 666). The lines of section pass through normal intestine, just proximally and distally to the portion of intestine involved in the invagination.

Partial Enterectomy of the Base of the Invagination, Followed by End-to-end Entero-enterostomy, Leaving the Isolated and Detached Intussusceptum to Be Passed by Rectum _ (Oderfeld's Technic).—The excision of the immediate site of beginning of the intussuscipiens is accomplished in the usual manner (Fig. 3990, **a**). Following section of the bowel it is of practical importance to see that the intussusceptum, now divided, is also free to travel on down the intestine (Fig. 3991, **b**), after which the free ends are united end to end.

Partial Enterectomy of the Site of Invagination, Followed by the Formation of a Temporary Artificial Anus.—This method should not be adopted unless the urgency of the case demand it _ especially in children. Following excision of the involved part of the intestine, both ends of the intestine are brought out of the abdominal wound, and a glass tube, of the Paul or Mixter type, tied in _ the abdominal wound being closed up to their exit. The intestinal tract is restored by some subsequent procedure.

Operation for Intussusception by the Jessett-Barker Method.—The intussuscipiens and intussusceptum are sutured together, and an incision is made through the wall of the intussuscipiens, over the base of the intussusceptum _ and, through this incision, the intussusceptum is excised _ the free ends of the intestine sutured _ and the window in the intussuscipiens closed. This technic has been suggested by nature's own method of occasionally curing such cases by spontaneous sloughing of the intussusceptum, within the line of adhesion, with the onward passage of the separated part Maunsell's method of end-to-end entero-anastomosis is an imitation of it. It may be regarded as the best type of operation for intussusception in the average run of cases.

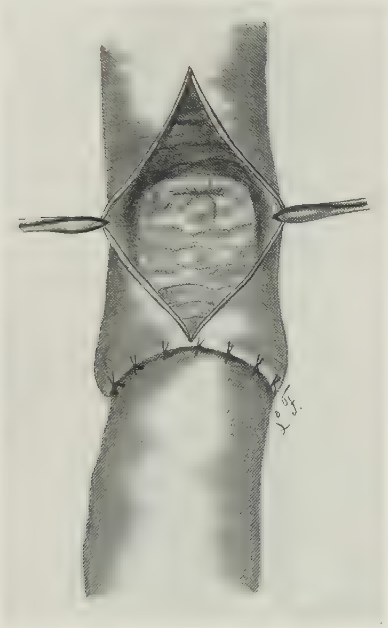


Fig. 3992.—The Jassett-Barker Operation for Intestinal Intussusception _ I; _ The intussuscipiens incised, exposing the intussusceptum.

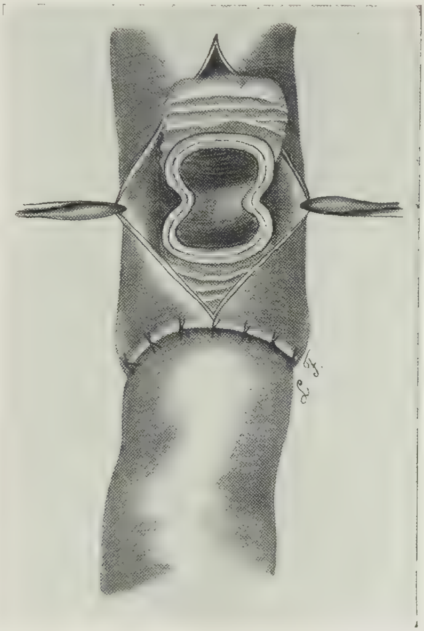


Fig 3993.—The Same _ II; _ The excision of the intussusceptum.

The preparation, position, landmarks, and incision are as of those for an abdominal section performed in the special locality indicated.

Having brought the site of intussusception into the field of operation, the intussuscipiens and intussusceptum are sutured together by a continuous or interrupted seromuscular suture at their line of invagination, including the mesentery (Fig. 3992). Having clamped off the field through the antimesenteric aspect of the intussuscipiens a longitudinal incision, 5 cm. (2 inches) in length, is made into the lumen of the intestine. Through this opening the invaginated portion of the intestine is drawn out (Fig. 3993). It is then divided transversely a short distance above the line of invagination. The free edges of the two concentric ends of intestine are now sutured together by means of an overhand interrupted or continuous suture _ which both controls hemorrhage and unites the serosæ of the severed ends (Fig. 3994). Sometimes it is easier to deliver the intussusceptum if the transverse section be made first. The stump of sutured intestinal ends is now dropped back into the lumen of the intussuscipiens _ after which the longitudinal incision in the intussuscipiens is closed by a line of continuous interrupted sutures _ reinforced by a row of Lembert stitches, interrupted or continuous (Fig. 3995).

Comment.—As the transverse section of the invaginated portion is being made, the free ends are clamped and held in the field until the sutures are placed.

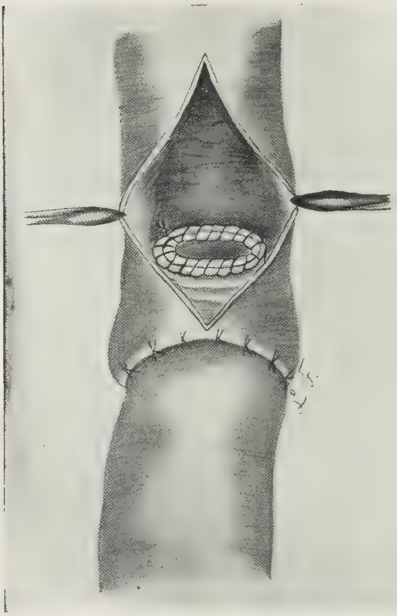


Fig. 3994.—The Same _ III; _ Suturing together the two concentric walls of the intussusceptum, following excision of the invaginated portion

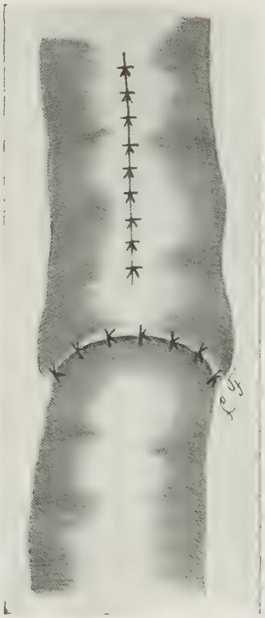


Fig. 3995.—The Same _ IV; _ Suturing the intussusceptum to the intussuscipiens, along their lateral surfaces of contact _ and closing the temporary window in the intussuscipiens.

If the invaginated portion of intestine cannot be detached readily, effort should be made to free it by manipulation, or by the passage of a long probe or sound between the walls of the two pieces of intestine.

In order to prevent hemorrhage during the division of the intussuscepted portion of the bowel, one may place the sutures in the concentric free margins as the section progresses.

Especial care is to be exercised in placing the sutures so that the mesenteric blood-supply will not be cut off, and also that the mesenteric folds brought about by the invagination will be preserved _ and, further, that pockets will not be left by unnatural puckerings.

OPERATIVE TREATMENT OF VOLVULUS

By volvulus is understood a condition of intestinal obstruction due to twisting or knotting of the bowel _ termed "simple," when a single loop of bowel twists around its mesenteric axis _ and "compound," when two loops become mutually twisted about each other.

Volvulus of the sigmoid colon is the most frequent _ but the cecum and transverse colon may also be involved _ as well as the jejunum and ileum. More than a single volvulus may be simultaneously encountered.

The abdomen is usually opened by a median subumbilical incision _ which affords approach equally well, to a volvulus of the sigmoid, cecum, or small intestines. This is the preferable incision, unless preoperative phenomena point to the desirability of incising through the outer aspect of either rectus, to reach the sigmoid or cecum. On opening the abdomen the conditions should be examined carefully, and the nature and explanation of the torsion learned. In proportion as the twisting, the extent of involvement, the distention, and adhesions are limited or extensive, will ease or difficulty be experienced in delivering the involved intestine from the abdomen. Effort should be first made to untwist the portion of intestine involved. Sometimes the distention is so great that no progress can be made until the intestinal contents, fluid or gas, are partly or entirely removed. One may, at first, try to accomplish this by passing these on along down the bowel, and out through the rectum and stretched anus _ but if this fails, which is apt to be the case, the contents may be removed by Moynihan's technic _ of passing a long, flanged glass tube into the bowel, through an incision in the intestine, in the manner already described (v. p. 631) _ or by an enterotomy incision. When the bowel has been brought out of the wound and emptied, it is generally much more readily untwisted, though the twist may return _ it is, however, less apt to do so than if distention remains. Evacuation of the intestinal contents by puncture, or incision, is the routine employed in the majority of cases, prior to being able to reduce the torsion _ and before being able to determine the condition of the intestinal walls, and deciding upon the best subsequent course to follow.

From the standpoint of the condition of the bowel, if this be unquestionably good, it is returned to the abdomen. If it be in a bad or doubtful state of vitality, one of several courses are usually open: _ An excision of the involved part may be made, followed by an entero-anastomosis between the free ends, _ Or two glass tubes may be tied into these ends, which are then brought out of the abdominal wound, as a temporary enterostomy, _ Or, if only suspicious, the loop may be anchored in the wound, to be opened later as an enterostomy, if necessary.

From the standpoint of possible recurrence, however, it is to be remembered that volvulus is usually the result of some anatomic condition _ and to make recurrence unlikely, the condition which caused it, in the particular case, should be sought, and, if found, rectified. The responsible anatomic abnormalities usually associated with volvulus are unusual length and freedom of mesentery, the presence of mesentery of the large intestine where it does not ordinarily exist, and the like. Such conditions are usually to be met by anchoring the free portion of the intestine in such a way as to make a repetition unlikely. Excision of the offending coil (if the length be not very great) _ together with the corresponding part of faulty mesentery _ is a radical method, and often the best to be adopted.

Volvulus of the small intestine in very young infants is generally due to narrowing of the mesentery.

Volvulus may involve the entire ileum and jejunum _ but the jejunum is said never to be involved alone.

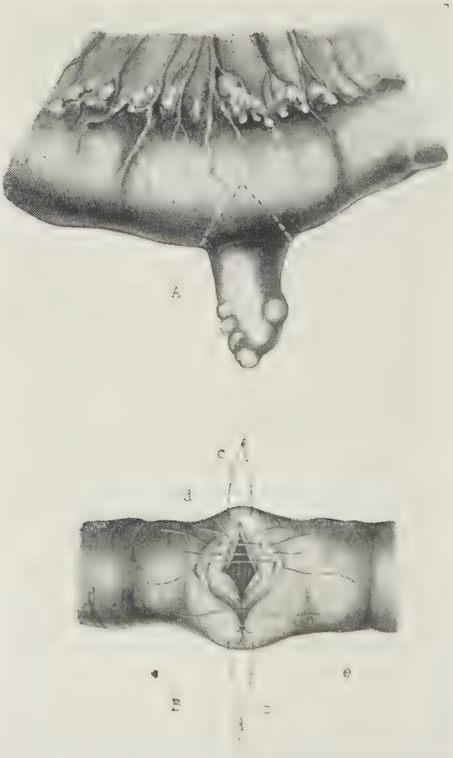
Volvulus of limited loops of the intestine are usually associated with such mechanical conditions as herniæ, or bands of adhesions or tumors _ the correction of the exciting cause serving to prevent recurrence.

Torsions of the small intestine occurring later in life are apt to occur in the lower part of the ileum.

While the performance of enterostomy is sometimes undertaken in desperate cases with the knowledge that it is not correcting the cause of the condition, yet it is often the only course available. Further, in such cases, it is often wiser to make one enterostomy at the site of involvement and another at some distance proximal to it.

EXCISION OF MECKEL'S DIVERTICULUM

The presence of Meckel's diverticulum _ the remains of the omphalomesenteric duct _ which is encountered in about 2 per cent. of persons _ is sometimes the cause of intestinal obstruction. Its removal, under such circumstances is indicated.



Figs. 3996 and 3997.—Excision of Meckel's Diverticulum: _ A, Line of wedge-shaped excision; _ B, suturing the site of excision: _ c, c, traction sutures, putting the part upon the stretch for suturing; _ d, non-penetrating approximation sutures; _ e, reinforcing Lembert sutures, burying in the preceding. (Redrawn from Schmieden.)

The structure arises from the ileum within an average of 91.5 cm. (36 inches) of the ileocecal junction. The structure varies from 5 to 20 cm. (2-8 inches) in length _ and may possess a very small caliber, or one equal to that of the ileum itself. It usually has a mesentery. Its proximal end is attached to and communicates with the ileum. The distal end may be free or may be attached to the umbilical cicatrix, to the mesentery, or to the intestine.

The abdomen is opened by a subumbilical median or right paramedian incision. On exposing the abdominal cavity, examination is made for the origin, course, and attachment of the diverticulum _ by hunting for its origin in its known locality, and for its distal attachment, by sweeping the hand over the peritoneal wall.

In operating upon the structure it is to be dealt with, as to clamping and safe-guarding against soiling, exactly as a piece of intestine _ owing to the lumen, continuous with that of the intestine, which is usually present.

After applying double clamps to the ileum, the best procedure is to excise the diverticulum by means of an elliptic incision, the axis of which is transverse (so as not to narrow the intestine in suturing) (Fig. 3996, A). Following excision the margins of the elliptic or lozenge-shaped opening are first brought together by through-and-through marginal sutures of fine chromic catgut _ reinforced by an outlying tier of silk Lembert stitches (Fig. 3997, B).

OPERATIVE TREATMENT OF ILEOCECAL ADHESIONS

("ILEAL KINK" _ "LANE'S KINK")

Ordinary adhesions, due to the different conditions which result in adhesions, may cause angulation and unnatural immobilization of the part of the ileum in proximity to the cecum through the medium of adhesions _ but the condition which has been popularly called "Lane's kink" is a separate and individual condition of its own, characterized by an angulation occurring

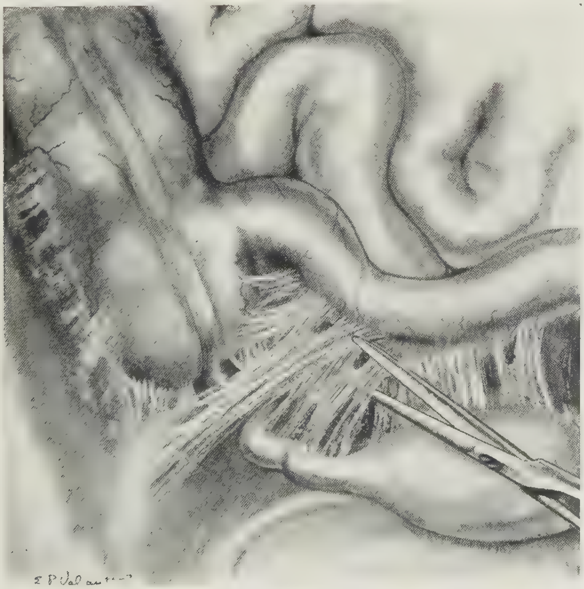


Fig. 3998.—Freeing Ileocecal Adhesions, Constituting "Lane's Kink."

within the last 15 cm. (6 inches) of the ileum, the central portion of the angulation presenting a downward concavity, and its two limbs tending to be united with each other by adhesions, or with the colon – or the ileum may be adherent to and enveloped by its own mesentery which, as it were, emprisons it. The condition is represented in Fig. 3998.

There is not unanimity of view as to its causation. Lane considers that the condition is brought about by traction of a prolapsed cecum, on the one hand, in conjunction, on the other, with a counterpull of an ileal mesentery fixed at a point about 7.5 cm. (3 inches) from its cecal attachment. The tendency of this pathologic arrangement is to partially obstruct the lumen of the ileum, and produce a chronic type of moderate obstruction.

Operation.—The first step, after opening the abdomen by right paramedian incision, consists in freeing the ileum. This is accomplished by separating the adhesions – by blunt dissection, if possible, or by cutting and ligating, if necessary. The appendix, which is frequently hidden in adhesions, is removed. The cecum, which often overlies the adherent appendix, is drawn outward. It is by putting the cecum and the beginning of the ileum upon the stretch that the adhesions are best displayed – and, while under tension, are more easily separated or divided – thus freeing the ileum and its mesentery. This, however, only partly solves the difficulty.

The next step of importance is to plan the prevention of recurrence – and a number of procedures have been suggested to avoid the re-formation of adhesions. The elevation and fixation of the cecum seem the most evident indications. In some marked cases Lane has suggested ileocolostomy, ileosigmoidostomy, and even colectomy. Martin, after separation of the adhesions in the Trendelenburg position, and adjusting the organs in normal position, applies a plaster cast around the closed abdomen, while the patient is in this position, counting upon the firmness of its application, and the retention of a modified form of this position during early convalescence, to correct the condition. Mayo covers with vaselin the surfaces left raw after freeing adhesion to prevent re-adherence. Hofmeister depends upon intestinal short-circuiting

CHAPTER LXXII

SPECIAL OPERATIONS UPON THE APPENDICOCECAL TRACT

Surgical anatomy of the appendicocecal tract, p. 781; _ General surgical considerations in operating upon the appendicocecal tract, p. 781.

Appendicostomy (Weir), p. 781.

Operations for appendicitis, in general, p. 784; _ Appendicectomy by McBurney's intramuscular technic, p. 785; _ Appendicectomy, in intermediate and late cases, by Battle, or Sprengel's vertical incision through the outer third of the right rectal sheath, with inward displacement of the rectus muscle, p. 799; _ Operation for suppurative appendicitis, with infective peritonitis, or intraperitoneal abscess, p. 802; _ Operations for isolated abscesses of appendical origin, adjacent to or remote from the appendix, p. 806.

Cecostomy, p. 809; _ Cecopexy, p. 811.

Cecectomy, with excision of the adjacent parts of the ascending colon and ileum, followed by ileocolostomy, p. 812.

Ileocecal exclusion without intestinal resection, p. 816.

SURGICAL ANATOMY OF THE APPENDICOCECAL TRACT

See Surgical Anatomy of the Intestines in General, pp. 611–618.

GENERAL SURGICAL CONSIDERATIONS IN OPERATING UPON THE APPENDICOCECAL REGION

See General Surgical Considerations in Operating Upon the Intestines, in General, pp. 620–629.

APPENDICOSTOMY

WEIR'S OPERATION

Description.—The operation is practically an enterostomy _ in which the appendix is made to open upon the skin surface _ and through which drainage and irrigation of the intestinal tract, and sometimes medication of the large intestine are carried on. This measure finds its chief application in intractable cases of amebic dysentery. The appendix is exposed through the steps of the McBurney intramuscular exposure of the organ.

Preparation _ Position _ Landmarks _ Incision.—As in McBurney's intramuscular appendicectomy (p. 785).

Operation.—The steps of the operation are carried out as detailed in the above operation. The appendix is isolated and delivered through the smallest available intramuscular opening (Fig. 3999). Whatever adhesions are encountered are separated. The appendix is put under gentle traction and drawn out of the abdomen until its base is in contact with the parietal peritoneum _ where it is anchored to the parietal peritoneum by two catgut stitches, one through the meso-appendix and one through the seromuscular coats of the antimesenteric aspect of the appendix. The muscles are all allowed to fall together _ and are reinforced by catgut suturing if indicated. The skin and fascia are sutured up to the exit of the appendix. The appendix itself, as its exit from the outer surface of the abdominal wall, is anchored to the skin by two seromuscular stitches of silkworm-gut or silk. If practicable, the appendix is not opened for a couple of days _ delaying until the general cavity is shut off by adhesions. The end of the appendix is then cut off transversely. Through its lumen a rubber or silk catheter is passed on into the cecum _ and through this catheter the bowel is irrigated, drained, or medicated. The catheter may remain *in situ* or be introduced during irrigations. When the appendicostomy has ceased to be of service, the wound sometimes closes spontaneously. At other times the abdomen must be opened by a repetition of the original steps and the appendix removed in the usual manner. The technic is seen in Fig. 3999.

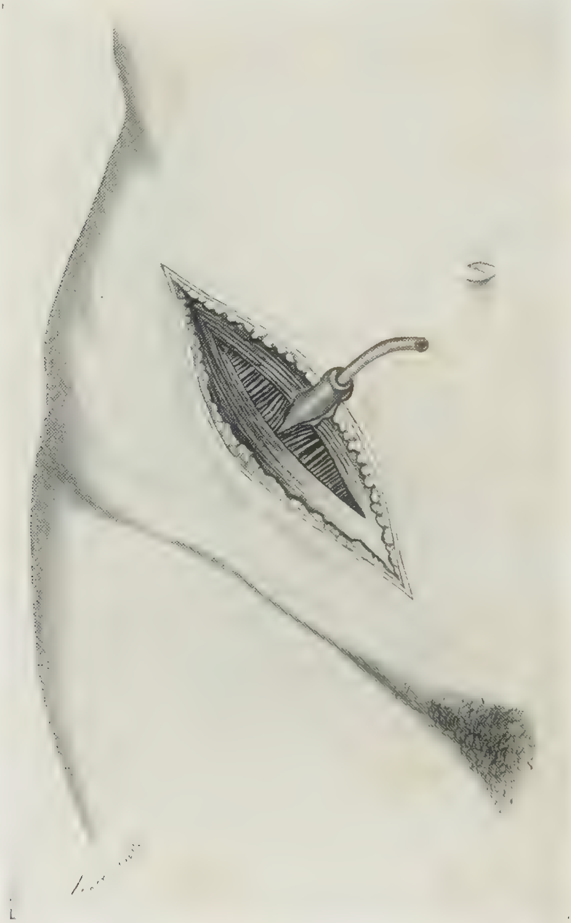


Fig. 3999.—Appendicostomy; – The appendix is seen emerging from between the separated fibers of the internal oblique, below – and between the separated fibers of the external oblique, above. A rubber tube is in its lumen

Comment.—In some cases the appendix cannot be brought into the wound, owing to its situation or to adhesions, and in such cases a cecostomy (v. p. 809) may be done through the same wound. This latter technic, indeed, is preferred by some Surgeons to an appendicostomy.

Owing to the valvular arrangement, fecal contents do not, ordinarily, escape through the appendicostomy opening.

The appendix is sometimes exposed through the Kammerer incision, p. 127.

The appendical artery is to be ligated distally to the first branch given off to the base of the appendix – which is of importance for the integrity of the organ. The mesentery of the appendix is severed after tying any vessel that may bleed.

In closing the wound care is exercised not to bring the parts so tightly together as to strangulate the protruding appendix. This should be wrapped in rubber tissue in applying the dressing.

It is of practical importance (which is sometimes omitted) to learn whether the lumen of the appendix is patulous _ for, of course, it may be obliterated by some previous involvement, and, in such cases, it is of no use, either as inlet or outlet. It is not, however, possible to determine this important fact at the time of the operation, unless the tip is then cut off, and the canal tested by a probe _ and this is, unquestionably, always the best course, even at the expense of possible soiling _ rather than to wait for a couple of days before excising the extremity of the organ. Under such circumstances a rubber catheter is at once tied in the appendix.

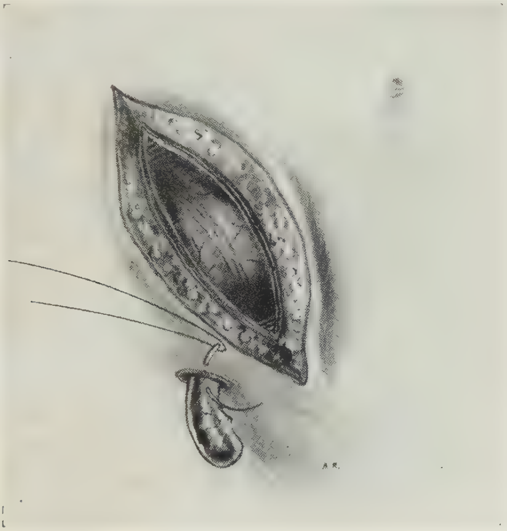


Fig 4000.—APPENDICOSTOMY _ in which the cecum and appendix are exposed through the main wound _ and the appendix is brought out of an adjacent secondary wound.

In those cases in which the lumen of the organ is obliterated _ as well as in those cases in which the appendix is so placed, or so distorted, that it cannot be delivered into the wound, cecostomy (v. p. 127) becomes an alternate operation _ which, as already said, is, even independently, preferred by some Surgeons to appendicostomy.

Makins sums up the usages of appendicostomy as follows: _ safety exit in cecal distention _ avenue of lavage and medication for the large intestine, and lower part of the ileum, especially in colitis _ route of evacuation, as an artificial anus, "as a means of evacuating stagnating intestinal contents from the proximal side of the ileocecal valve" (Ewart), and "as an artificial anus in malignant disease of the colon" _ avenue of lavage in marked chronic constipation.

Sometimes the cecum and appendix are exposed through the main wound _ and then the appendix is brought out of a smaller, adjacent wound _ which then allows the main wound to be entirely closed. This procedure is seen in Fig. 4000.

OPERATIONS FOR APPENDICITIS, IN GENERAL

Object of Operation.—The ideal goal in operating for appendicitis, at any stage of its existence, or at any period between attacks, is the total removal of the appendix _ appendicectomy.

As desirable as this is, it is not always possible. In non-early operations, which, owing either entirely to pathologic conditions, resulting in dense adhesions, or, partly to these and partly to the position of the individual appendix, the appendix is, often, simply not removable without a degree of traumatism which is not considered advisable. In such cases, if the appendix be quiescent, it is sometimes wiser, though exceptionally, to expose the base of the appendix, at its entrance into the cecum, and merely doubly ligate and divide it _ burying the base in the cecum, by invagination, as usual, and leaving the distal portion of the organ *in situ*. In other instances, on the other hand, it may be found impossible to remove the appendix for quite different reasons _ such as not only extensive adhesions, but because of extensive infection, suppuration, and disintegration of the structure itself _ in which circumstances no attempt is made to remove the appendix, and in which only free drainage of the site of the appendix and the focus, or foci, of involvement is wisely indicated _ rather than make bad matters worse by injudicious attempts of digging out such appendices or remains of such appendices. Strictly speaking, therefore, the operation in which the appendix is not literally removed is incorrectly called an "appendicectomy." If the appendix is simply doubly ligated, divided, the stump invaginated into the cecum, and the distal portion of the appendix left *in situ* (rarely warrantable), the technic, correctly speaking, is a complete transverse appendicotomy (as unusual as this expression may be). Where the ruptured appendix is neither removed nor divided, but simply drained, the operation can only be named "drainage for appendicitis."

Period of Operation.—The designation of the operation based upon the time of its performance is somewhat conventional, but of practical consideration.

(*a*) Early Operations: _ operations performed within the first forty-eight hours, preferably within the first twenty-four hours _ sometimes called "operation of election."

(*b*) Intermediate Operations: _ from the beginning of the third to the end of the sixth day _ sometimes termed "operation of necessity" _ in which difficulties and complications are to be expected.

(*c*) Late Operations: _ after the sixth day, but during the continuation of some phase of the attack _ in which there is not to be expected the simplicity of the early operation nor the extreme complications of the intermediate operation.

(*d*) Interval Operations: _ at some period after complete subsidence of acute or subacute attacks. The operation of choice.

Incisions of Approach.—The selection of the method of exposing the appendix is determined, chiefly, by the conditions expected to be encountered, based upon the period of operation. Early operations and interval operations require, ordinarily, the minimum opening and the simplest technic _ such as is furnished by the intramuscular type of operation approached through an oblique incision. Intermediate operations and late operations usually require the maximum opening, and involve the most difficult and extensive technic, because of the complications which are apt to be encountered _ such openings as are generally secured by an operation through the outer fibers of the right rectus muscle, or, better, to the outer side of the rectus, but within its sheath, approached through a longitudinal incision, followed by the inward retraction ot the muscle.

While a variety of incisions and technics have been employed for the various conditions encountered in connection with appendicitis, the oblique incision, followed by the intramuscular method of McBurney (with the possibility of its extension through the Weir technic, p. 125) – and the longitudinal incision over the outer aspect of the right rectus, followed by the inward retraction of the muscle – usually suffice to meet all conditions which are apt to occur.

Two incisions closely allied, in general aspects, with the latter of the two above mentioned, are the following: – the vertical pararectal incision, through the right linea alba, just to the outer side of the right rectus, – and the right paramedian incision, to the outer side of the median line, on the right, followed by the outward displacement of the right rectus muscle by retraction.

APPENDICECTOMY IN EARLY AND INTERVAL CASES

BY MCBURNEY'S INTRAMUSCULAR OPERATION THROUGH AN OBLIQUE INCISION

Description.—Appendicectomy consists in the removal of the appendix vermiformis. The feature of McBurney's operation, begun by an oblique incision, is based upon the exposure of the appendix through a successive separation, in the cleavage line, of the overlying abdominal muscles and aponeuroses. The fibers of the muscles and aponeuroses are not cut, but are drawn apart. The appendix is exposed and is treated by one of several methods. This form of the operation is chiefly applicable to non-suppurative, early cases, or to the "interval period" of appendicitis – but is sometimes used in the suppurative and complicated cases of the intermediate and late type.

Preparation.—Site of incision to be shaved.

Position.—As in median abdominal section.

Landmarks.—McBurney's point, which is located on an imaginary line extending from the anterior superior iliac spine to the umbilicus, at a distance of 3.8 cm. (1½ inches) internal to the anterior superior iliac spine.

Incision.—Commences about 2.5 cm. (1 inch) above the imaginary line just mentioned, and passes obliquely downward and inward in the direction of the fibers of the external oblique muscle and aponeurosis – crossing the above line at McBurney's point – and ending about the same distance below as above it. The length of the incision may be greater or less than the above, according to the space required. A free skin incision greatly aids the muscular retraction (Fig. 4001, **a**).

Operation.—Having incised the skin and fascia in the above line (which will correspond with the cleavage line of the skin), and having controlled hemorrhage and retracted the lips of the wound, the muscular and tendinous fibers of the external oblique will be exposed. Incise the external oblique with a sharp scalpel, directly in a line with its muscular fibers above, and their tendinous continuation into the aponeurosis below – continuing the separation with scalpel and scissors, incising between the fibers without severing them (Fig. 4002). The two lips of the incised external oblique are drawn respectively upward and inward, and downward and outward – thus exposing the intermuscular fascia between the external and internal oblique.

The sheath and fibers of the internal oblique (the muscle being here quite thick) are now similarly separated by scalpel, scissors, or blunt dissection, in the line of their cleavage (which is nearly at a right angle to the cleavage line of the fibers of the external oblique), the center of the separation of the fibers being about opposite the anterior superior iliac spine. The lips of the internal oblique are now retracted respectively upward and outward, and downward and inward — thus exposing the intermuscular fascia between the internal oblique and transversalis. Guard with special care all nerves lying in this intermuscular plane (Fig. 4003).

The fibers of the transversalis which, for practical purposes, run very nearly in the same direction as those of the internal oblique, are now similarly separated in their cleavage line. The lips of the transversalis may be separately retracted upward and downward, but are generally included in the grasp of the same retractors which retract the internal oblique. The transversalis fascia at the bottom of the wound is thus exposed for 2.5 cm. (1 inch) or more.

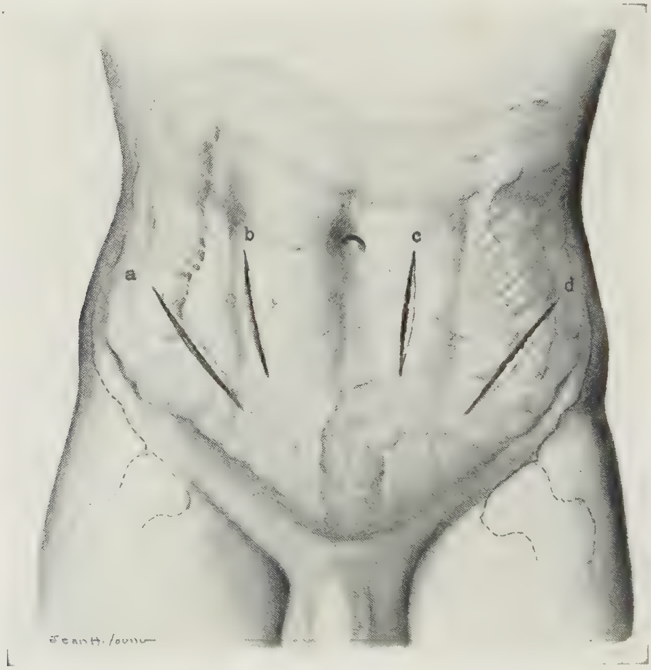


Fig. 4001.—Lines of Incision in Performing Appendicectomy and Colostomy: — **a,** McBurney's intramuscular exposure of the appendix; — **b,** Lennander's or Battle's intramuscular exposure of the appendix through the outer third of the right rectus; — **d,** intramuscular left inguinal colostomy — through the same technic as in McBurney's operation; — **c,** intramuscular colostomy through the middle of the left rectus.

The transversalis fascia is grasped with forceps and divided in the line of the transversalis muscle (transversely) — when the subserous areolar tissue and peritoneum will be exposed.

The peritoneum is seized with two delicate toothed forceps, manipulated as in the median abdominal section, and divided with scissors to a limited and guarded extent. One blade of the scissors is then carefully introduced within the abdominal cavity and the opening enlarged toward the median line and the anterior superior iliac spine. The subperitoneal areolar tissue, transversalis fascia, and peritoneum may be simultaneously incised — but it is better to incise down to and recognize the peritoneum, and then to incise it separately and alone.

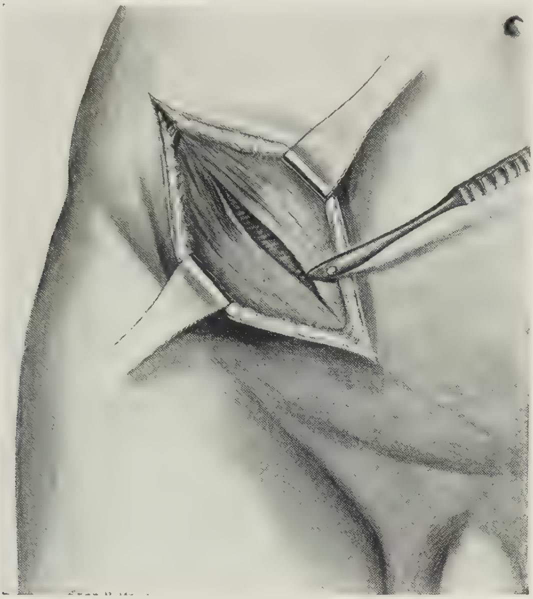


Fig. 4002.—Appendicectomy by McBurney's Intramuscular Method ‗ I; ‗ Separation of the fibers of the external oblique muscle and aponeurosis in their cleavage line by blunt dissection. The internal oblique is seen beneath.

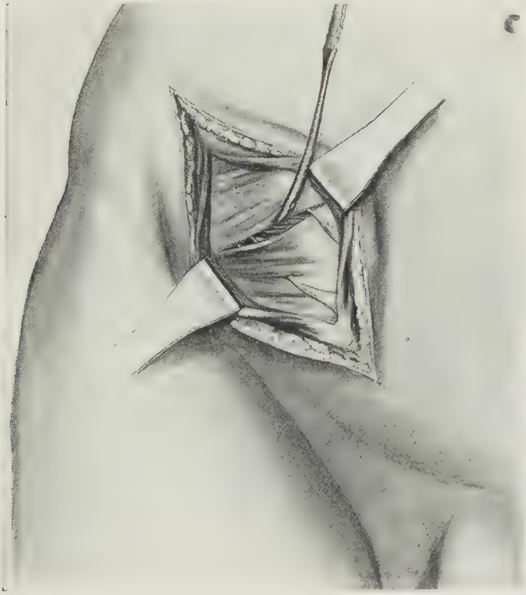


Fig. 4003.—McBurney's Intramuscular Operation for Appendicectomy ‗ II; ‗ The external oblique muscle and aponeurosis have been split in their cleavage line ‗ and their margins retracted ‗ exposing the internal oblique ‗ which is also being split in its cleavage line by a blunt dissector ‗ revealing the transversalis beneath it ‗ with branches of the eleventh and twelfth intercostal nerves intervening.

The right index-finger is inserted within the abdominal cavity and the appendix sought. The caput coli, or some part of the ascending colon, is generally encountered at once — and may even bulge into the wound. Sometimes the appendix itself presents — though exceptionally. If the appendix is not at once manifest, its base is sought in its usual position — that is, upon the internal and posterior aspect of the cecum, about 1.7 cm. (11/16 inch) below the ileocecal valve. If the appendix is not readily found by this maneuver, draw out the first part of the ascending colon encountered, and then follow it down to the caput coli — the anterior of the three longitudinal bands of the colon will lead to the base of the appendix (Fig. 4004). The appendix is now drawn out of the wound, and its treatment will depend upon the nature of the appendix and the individual views of the operator. (See Fig. 4005.)

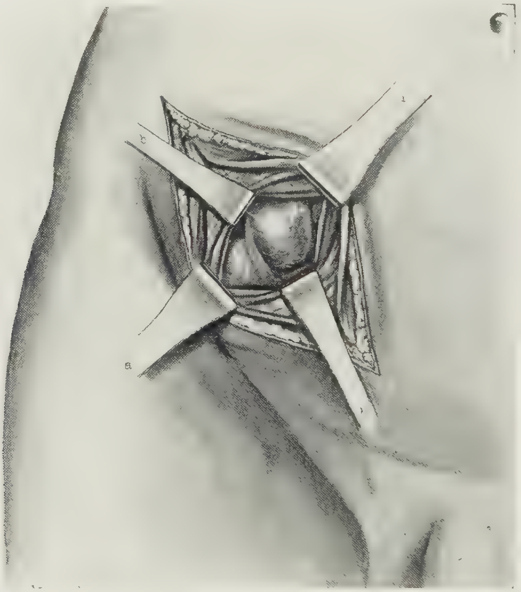


Fig. 4004.—The Same — III; — The fibers of the external oblique, **a, a,** are retracted inward and upward, and downward and outward. The fibers of the internal oblique are retracted upward and outward, and downward and inward, **b, b.** The split margins of the transversalis are usually drawn apart by these last retractors — though they are sometimes drawn directly upward and downward by a third pair of retractors. The transversalis fascia and peritoneum are then incised — exposing the cecum — the anterior band of which usually leads down directly to the base of the appendix.

As soon as the appendix has been delivered without the abdominal cavity it, or the mesentery near the tip, is grasped with forceps. The mesentery of the appendix is then ligated off with chromic gut, carried in a laterally curved aneurysm needle, or by other device proceeding from apex to base (Fig. 4005) — or in the opposite direction if more convenient — and tied in sections — the mesentery being then divided between the appendix and ligatures or the mesentery may be tied by a single ligature, across its base (Fig. 4006). The main artery near the base should be securely tied. If the appendix be bound down by adhesions, these should be separated by blunt dissection, or ligated and cut. Often the mesentery of the appendix must be ligated off within the wound before the appendix can be delivered. The peritoneum should be sutured over the stump of the mesentery.

The appendix is now to be disposed of in one of several ways. The following methods of treating the appendix may be used:

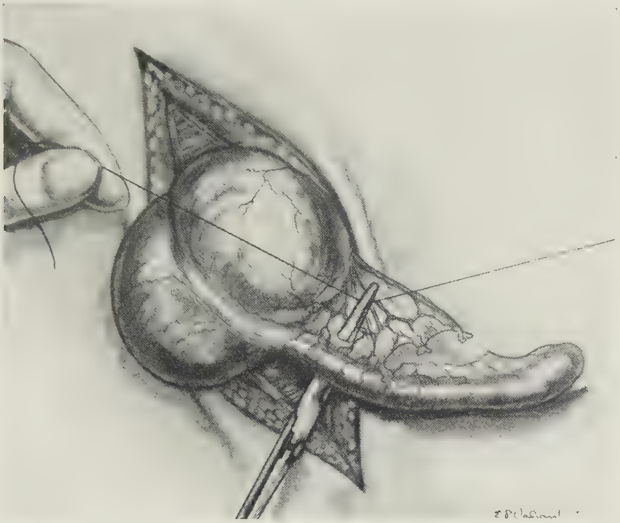


Fig. 4005.—Ligating the Meso-appendix by Puncturing the Mesentery with a Sharp-pointed Clamp, in Segments, and Drawing the Ligatures Through the Puncture Openings.

(*a*) Dawbarn's Purse-string Method: While the appendix is held upward, under slight tension, a continuous silk purse-string suture is passed through the serosa, muscularis, and into the submucosa of the cecum, encircling the base of the appendix, at a distance of about 6 to 12 mm. ($\frac{1}{4}$–$\frac{1}{2}$ inch) from the base of the appendix – but is not, at first, tied. This purse-string suture may be carried upon a straight needle held in the fingers – or in a curved needle

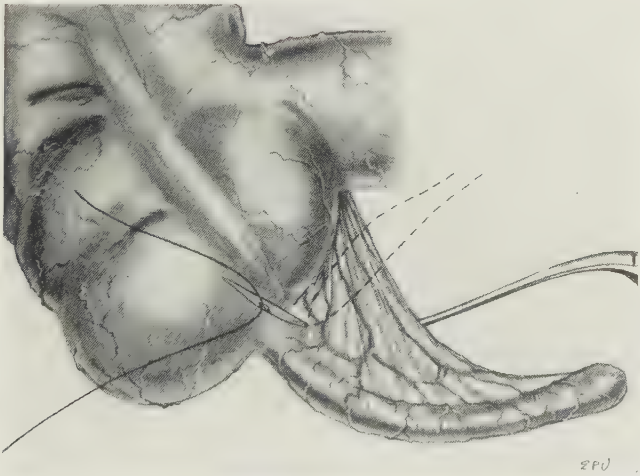


Fig. 4006.—Tying Off the Base of the Meso-appendix by Puncturing Its Substance with a Threaded Aneurysm Needle – or by a Reverdin Needle, in One Step.

held in a needle-holder (Fig. 4007). The loop opposite the free end of this purse-string suture is grasped by forceps held by an Assistant (Fig. 4008) to steady the appendix against the counterpull of the operator, who holds the free ends. The appendix is then divided transversely about 1.2 cm. (½ inch) from its base _ the canal of the stump after probing, to prove its patulousness may be dilated with special forceps (to aid in invagination) _ Fig. 4009 _ and is sometimes first sterilized by the actual cautery point _ the free end of the stump is then seized with the same forceps and invaginated into the cecum (Fig. 4010). While the stump of the appendix is held invaginated into the cecum, the operator draws upon the free ends of the purse-string suture (which have been loosely knotted with a friction-knot) until the slack of the loop held by the Assistant is taken up _ the Assistant, letting go his grip of the loop with the forceps, takes the two free ends of the suture _ tightening the friction-knot accurately at the very moment the operator quickly withdraws the invaginating forceps. A second knot is tied and the ends cut short. If considered necessary _ and it is safer _ two or three interrupted gut Lemberts may be used to further bury in the stump. This method of

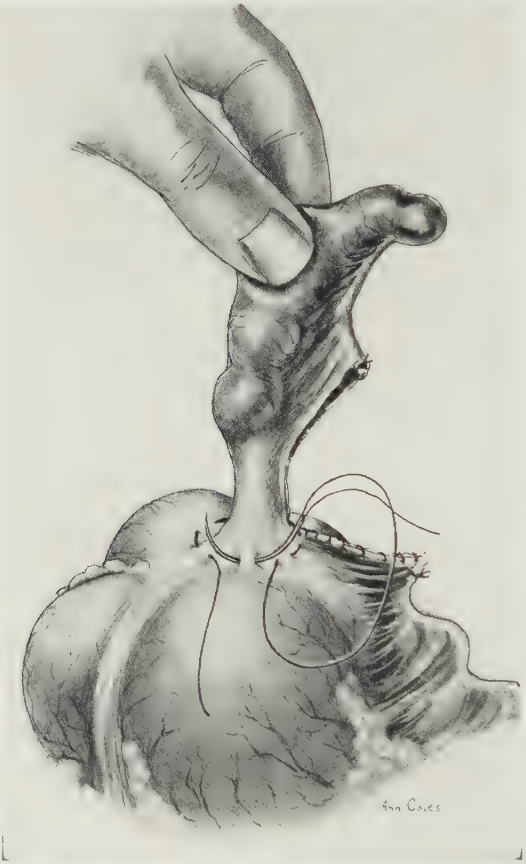


Fig. 4007.—PLACING THE PURSE-STRING SUTURE AROUND THE BASE OF THE APPENDIX _ which has been freed of its mesentery and put under slight upward tension _ the sutures passing through the serosa and muscularis and into the submucosa.

closure is especially applicable to appendices whose walls are of more or less natural thickness and softness – capable, in other words, of invagination.

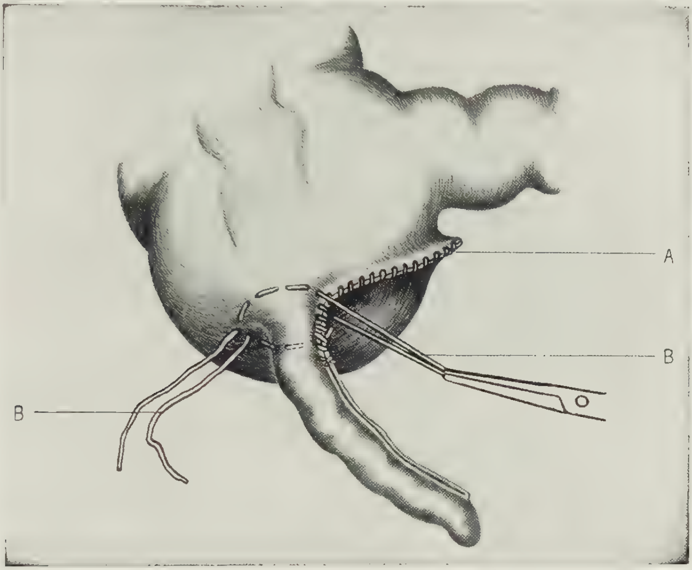


Fig. 4008.—Placing the Purse-string Suture Around the Base of the Appendix – by Dawbarn's technic.

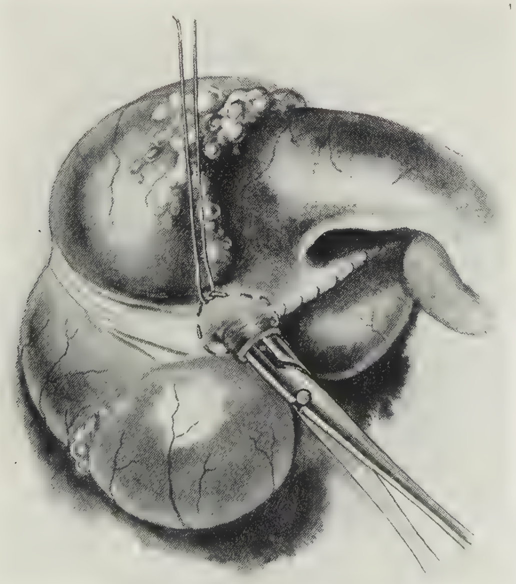


Fig. 4009.—Dilating the Canal of a Thickened Appendix Preparatory to Invagination – Where otherwise, invagination would be difficult

(*b*) Fowler's Cuff Method: Divide circularly the peritoneal coat of the appendix about 6 mm. ($\frac{1}{4}$ inch) from the cecum – peel back this serous coat toward the cecum _ and, on a level with the turned-back serosa, divide the middle and internal coats of the appendix very near the cecum (see Fig. 4011, A and B). See that the lumen of the stump is patulous by means of a probe, and cauterize the interior of the stump with a fine Paquelin point. The edges

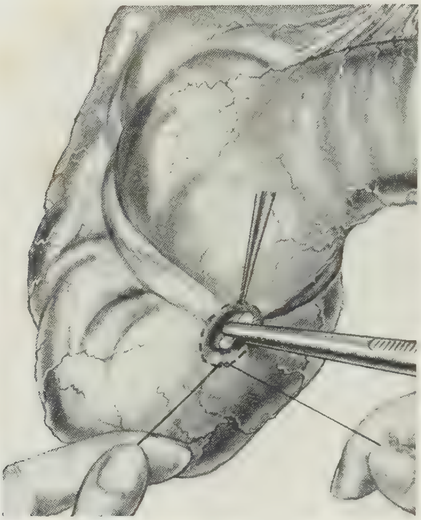


Fig. 4010.—The Invagination of the Stump of the Appendix _ By means of a smooth-bladed, broad forceps _ while counterpressure is being exercised by means of the free ends of the suture, on the one hand, and forceps grip upon the midpoint of the suture, on the other.

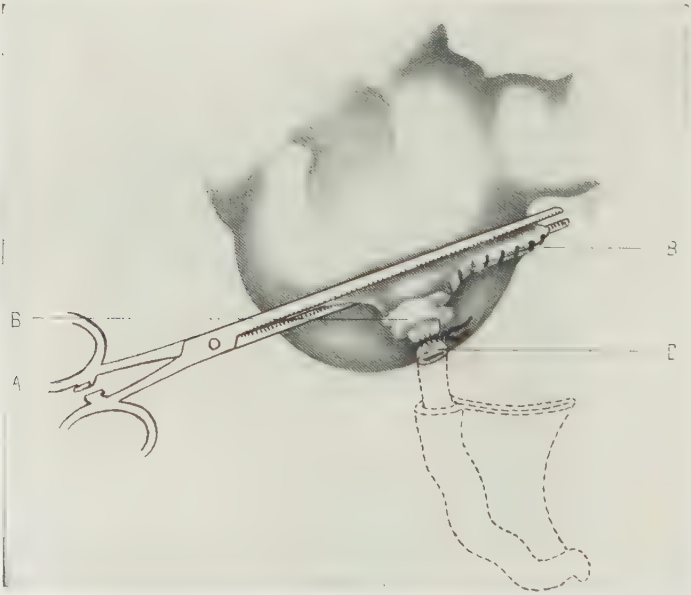


Fig. 4011.—Appendicectomy _ Fowler's Method of Dealing with Thick Appendices by Ligation and Depression into Cecum: _ A, Clamping off appendix from cecum; B, cuff of serosa turned back; C, stump of appendix ligated; B (to right), edges of mesenteriolum sutured.

of the stump are then brought together either by fine silk sutures or by circular ligature. This short stump itself is then depressed (rather than invaginated) into the cecum (see Fig. 4012) _ and the serosa sutured over the stump _ or the surrounding area of the cecum, to the extent of 3 mm. ($\frac{1}{8}$ inch) from the base of the appendix, may be invaginated by means of a purse-string suture which had been previously placed in the same manner as in the last method (Fig. 4013). This method is particularly applicable to thick, hard, narrow calibered appendices.

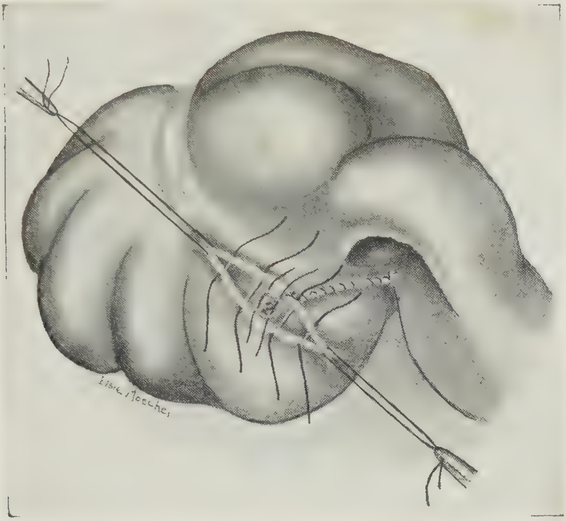


Fig. 4012.—The Same _ The cuffed-back base of the appendix has been ligated _ and two sutures are in the act of closing the margins of the peritoneum turned back over the stump _ after which the immediate site of the base of the appendix will be buried in by a row of Lembert sutures _ conveniently placed by ridging up the adjacent cecum in the manner shown in the illustration. The mesentery of the appendix has been ligated and whipped over.

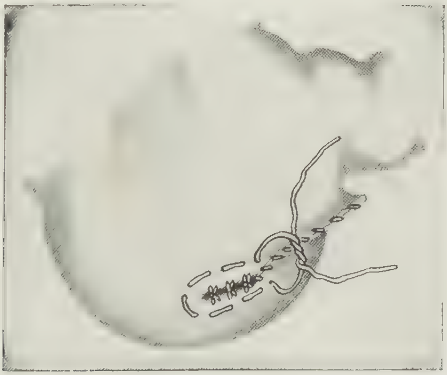


Fig. 4013.—Reinforcing Lembert Stitches by a Purse-string Suture; _ The depressed appendix stump and the invaginated serosa themselves invaginated into the cecum by a purse-string suture of the surrounding area.

(*c*) The peritoneal coat may be peeled back – the middle and internal coats divided transversely – and the peritoneal coat sutured over the cut middle and internal coats with Lemberts.

(*d*) The mucous coat may be excised with fine, curved, sharp-pointed scissors, or burnt out with the actual cautery – and the serous and muscular coats sutured over it.

(*e*) The same steps may be carried out as in *b*, except that the stump may be simply depressed into the cecum and the walls of the cecum brought together with Lembert sutures in a straight line. Methods *c*, *d*, and *e* are inferior to the other methods.

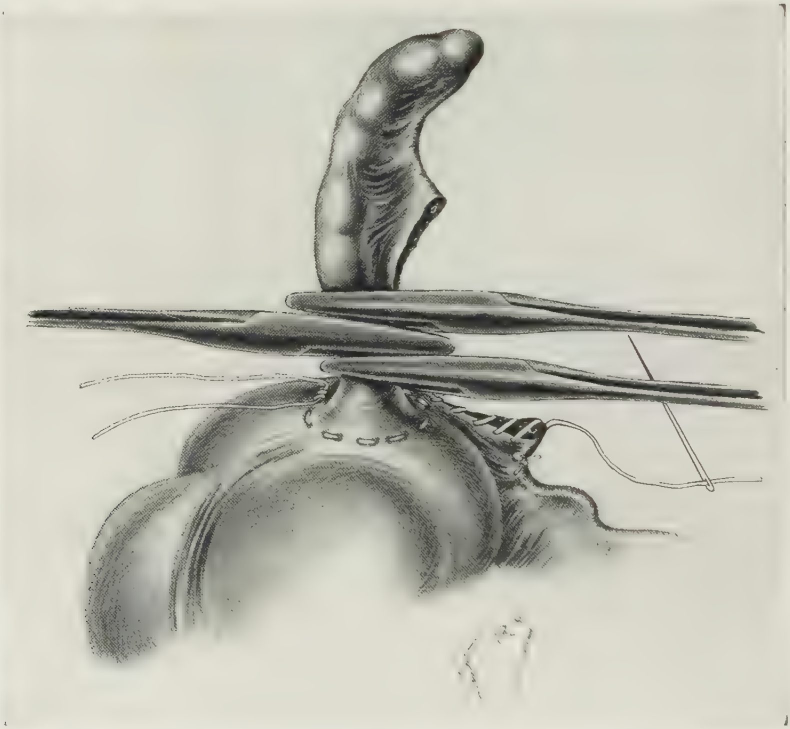


Fig. 4014.—Halsted's Three-clamp Method of Removing the Appendix – I; – Dawbarn's purse-string suture surrounds the base of the appendix. The artery of the mesentery is ligated and the severed margins sutured by an overhand suture. The appendix is crushed by three parallel artery clamps.

(*f*) The Halsted "three-clamp" method of removing the appendix is especially to be recommended. The appendix is clamped near its base with a clamp strong enough to crush it (a large size artery clamp) – a second one is applied above this, with handle in the opposite direction – and a third one below the middle one, with its handle running with the uppermost (Fig. 4014). The middle clamp is then removed – and the crushed appendix severed with the actual cautery (Fig. 4015) – after which it is invaginated into the cecum and the purse-string suture tightened – and the site reinforced by two or more Lemberts (Fig. 4010).

The appendix having been removed, its base disposed of by one of the special methods, and the peritoneal toilet completed, the abdomen is closed – without drainage, in clean, uninfected cases. The parietal peritoneum and subserous areolar tissue are first brought together by fine, plain catgut. Following this, the three muscles which have been separated in their cleavage line are brought together by tier suturing – and so naturally do they tend to fall into place that their split margins lie in contact, with a tendency to remain in contact, so that but little difficulty is experienced. The suturing is usually accomplished by No. 2 chromic catgut. In well-developed transversales, prominently separated, the margins of this muscle are sutured as the first layer – otherwise the margins of it and the internal oblique are sutured in one tier, running so nearly, as they do, in the same direction. Then the margins of the internal oblique, as the second tier (where it is sutured separately from the transversalis) – and, finally, the borders of the external oblique muscle, and its aponeurosis, at the lower aspect of the wound. Unless the fascia is very thick, it and the skin are sutured as the outermost tier. The technic of this suturing is indicated, in the main, in Fig. 4016.

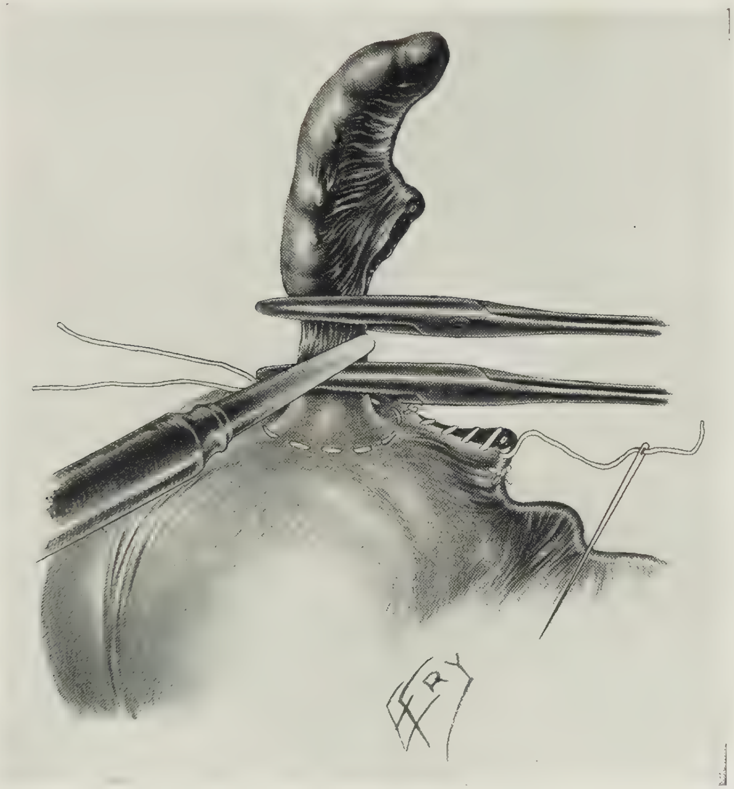


Fig. 4015.—Halsted's Three-clamp Method of Removing the Appendix – II; – The central clamp is removed and the appendix severed through its crushed portion by the actual cautery.

In the category of cases in which the McBurney operation is usually applied, the question of drainage rarely comes up.

Comments.—It is sometimes convenient to ligate the meso-appendix by puncturing the latter with sharp-pointed forceps, and drawing the ligatures through the openings thus made (Fig. 4017). The securing of the base of the meso-appendix by ligature is really all that is usually required, provided the ligature includes all of the vascular supply. Such a ligature may be con veniently placed with an aneurysm needle – or, with especial facility, with a Reverdin needle.

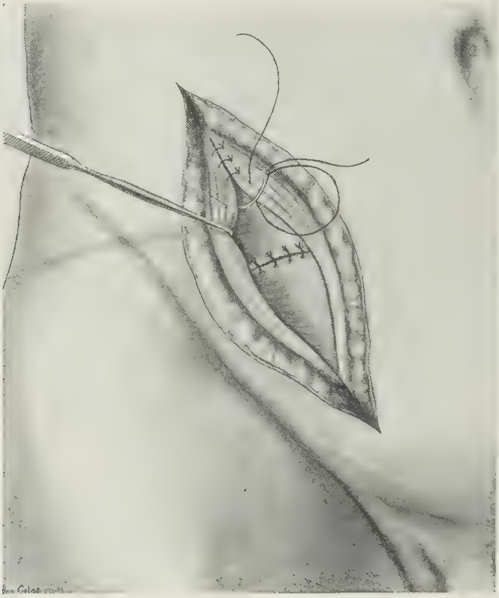


Fig. 4016.—McBurney's Intramuscular Appendicectomy; – At the end of the operation the several structures split and incised are repaired by suture, in the reverse order – including the anterior and posterior layers of the rectal sheath.

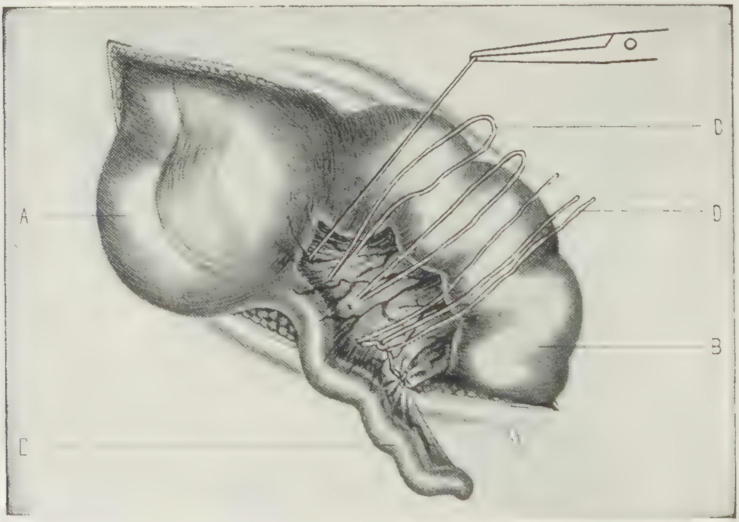


Fig. 4017.—Ligating the Meso-appendix – By drawing loops of a ligature through from the posterior to the anterior aspect, and cutting and tying them as separate ligatures.

The base of the mesentery which is to be ligated, as well as the site of ligating the appendix, are both often previously crushed with an enterotribe – and the ligatures then tied in the beds of the crushed tissues (Fig. 4018). A convenient instrument for crushing the appendix is Kelly's appendicectomy compression forceps, shown in Fig. 4019.

The purse-string suture surrounding the base of the appendix may be very expeditiously and easily placed by means of an appropriate Reverdin needle (v. Fig. 4020).

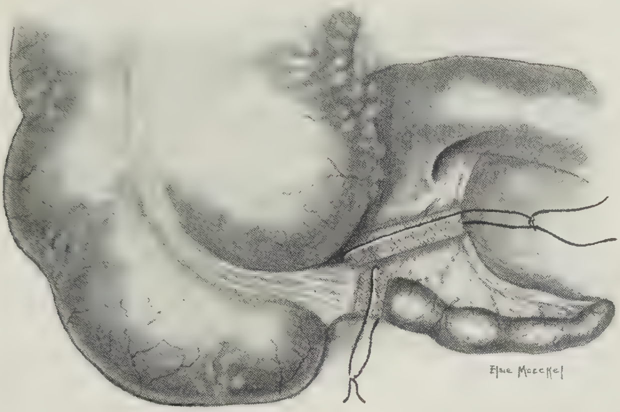


Fig. 4018.—Ligating the Mesentery of the Appendix and the Base of the Appendix After Crushing These Structures – using a small enterotribe or special crushing forceps.

After invaginating the stump of the appendix by means of the tightened and tied purse-string suture, the site of invagination is usually reinforced either by a second purse-string or by a few Lembert stitches. If a second purse-string suture be anticipated, it should be placed before the first is tied (Fig. 4020).

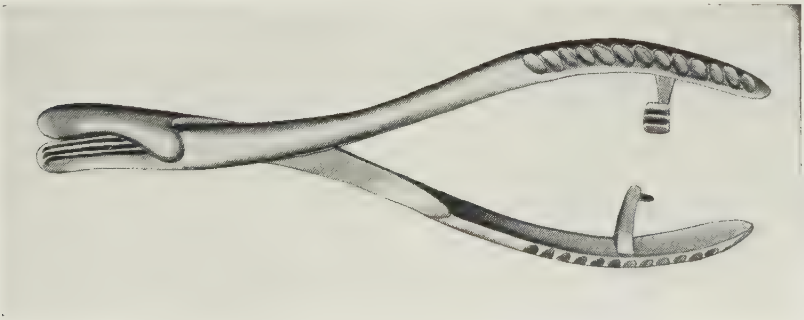


Fig. 4019.—Kelly's Appendicectomy Compression Forceps.

It frequently happens that the intramuscular incision of approach does not furnish sufficient working room in which to carry on the technic necessitated in the special case. Under these circumstances the original opening may be increased by the Sprengel or Weir technic of abdominal section already described (v. p. 125) – in which the usual incision (Fig. 4021) is prolonged, at its inner end, until the outer part of the anterior sheath of the

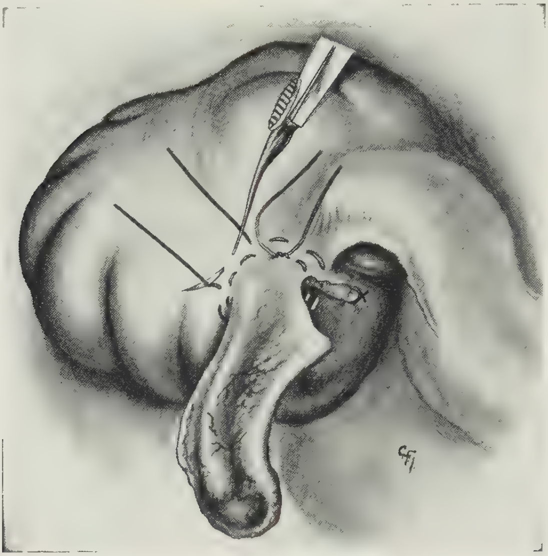


Fig. 4020.—The Placing of One or More Purse-string Sutures Around the Base of the Appendix by Means of a Reverdin Needle _ Preparatorily to Amputation of the Appendix and Invagination of the Stump.

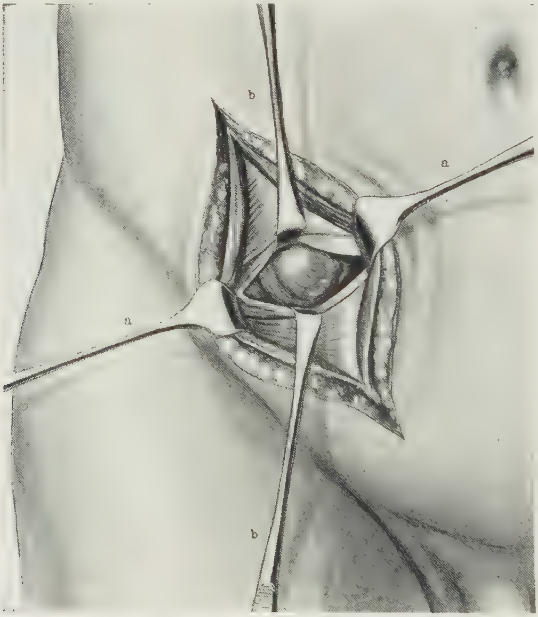


Fig. 4021.—Sprengel's, or Weir's Method of Enlarging the McBurney Intramuscular Incision _ Where More Room is Required During Operation _ I: _ **a, a,** Retractors of the split external oblique; _ **b, b,** retractors of the split internal oblique and transversalis.

rectus is divided in the line of the original incision _ after which the outer border of the right rectus is retracted toward the median line _ and the posterior layer of the sheath is cut in the same line (Fig. 4022) _ after making provision for either drawing the epigastric vessels out of the way, toward the median line, or for ligating them. The incision may also be extended from its upper and outer end.

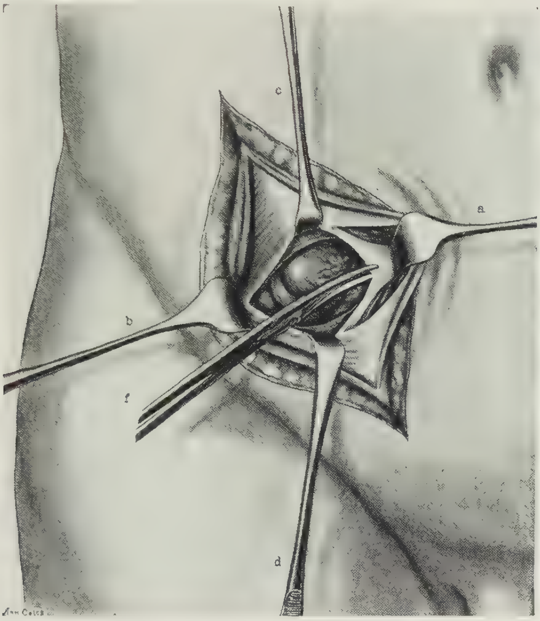


Fig. 4022.—The Same _ II; _ The incision is continued to the outer border of the anterior layer of the rectal sheath, which is incised in a continuation of the same line _ after which the outer border of the rectus muscle is retracted inwardly, a _ and the posterior layer of the rectal sheath similarly incised, with scissors, f _ retracting or ligating the epigastric vessels as indicated. The transversalis fascia and peritoneum are then incised.

In concluding the operation the rectal sheath is closed by suture _ and the muscle margins as in the simple operation (v. Fig. 4016).

APPENDICECTOMY, IN INTERMEDIATE AND LATE CASES, BY BATTLE'S VERTICAL INCISION THROUGH OUTER THIRD OF RIGHT RECTAL SHEATH, WITH INWARD DISPLACEMENT OF THE RECTUS MUSCLE

Description.—A longitudinal incision is made over the outer third of the rectus muscle, through its anterior sheath, parallel with the right semilunar line, and with its center opposite the estimated position of the appendix. Upon exposing the anterior aspect of the right rectus, its outer border is mobilized, after retracting outward the split margins of the rectal sheath, _ and the whole muscle displaced inward _ after which the posterior layer of the rectal sheath is incised to correspond with the incision through the anterior layer _ and the abdomen entered. At the end of the operation _ unless drainage be established _ both layers of the sheath are sutured, the muscle falling back into place, thereby protecting the site of incision. This form of operation is especially applicable to the intermediate and late cases _ where suppuration and complications are apt to be encountered. Most Surgeons, however, use this form of operation as a routine for all cases. In this latter connection it is to be noted that if the case proves a simple one, the operation amply suffices _ and if it proves a suppurative, or complicated one, better provision is probably made for dealing with these conditions than would have been the case with the simple intramuscular type of operation without the Weir addition. Further, drainage can be better accomplished through this form of exposure than through the intramuscular or "grid-iron" exposure. This method furnishes the largest exposure and the freest drainage for the appendical problem itself _ and, additionally, the incision can be extended upward and downward.

Preparation _ Position.—As in the intramuscular type of appendicectomy.

Landmarks.—Right semilunar line; the anterior superior iliac spines.

Incision.—The incision generally used is practically vertical _ though originally planned to be parallel with the right semilunar line, which is slightly oblique _ the incision lying from 1.2 to 2 cm. ($\frac{1}{2}$–$\frac{3}{4}$ inch) within the outer rectal border _ and its center corresponding with a transverse line between the two anterior superior iliac spines.

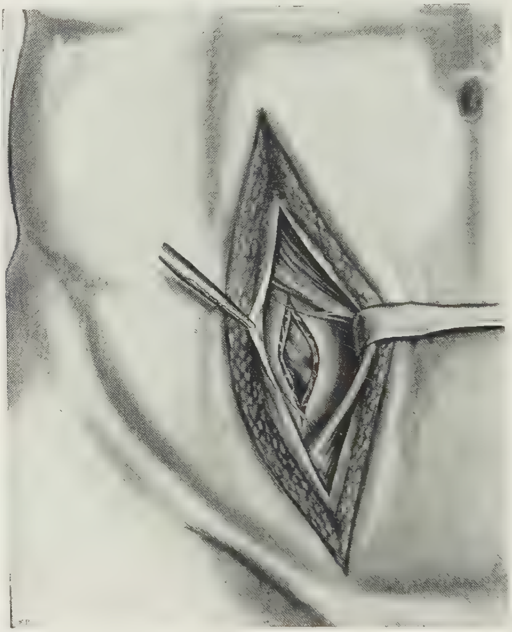


Fig. 4023.—Appendicectomy by Lennander's or Battle's Vertical Incision Through the Outer Third of the Right Rectal Sheath, with Inward Displacement of the Rectus Muscle; _ The outer part of the anterior sheath has been retracted outward, while the inner part, together with the attached rectus, has been drawn inward, exposing the posterior layer of the rectal sheath _ which is to be incised along the dotted line. Branches of the lumbar arteries and of the eleventh and twelfth intercostal nerves are encountered.

Operation.—The incision passes through skin, fascia, and through the anterior rectal sheath. The outer part of the rectal sheath is then retracted outward _ and with his index-finger, or with a blunt dissector, the Surgeon first mobilizes the outer border of the right rectus and then displaces the muscle and the still attached anterior sheath inward (Fig. 4023). The deep epigastric vessels are exposed, as they lie upon the posterior rectal sheath and, if in the way, are drawn inward along with the rectus muscle, out of harm's way. The posterior rectal sheath (which is thin), together with the subperitoneal areolar tissue, and the peritoneum are then all divided together to the length of the incision through the anterior sheath, and in the same direction.

In the course of this incision and muscle separation a transversely running lumbar arterial twig or two and two branches of the twelfth intercostal nerve (or branches of the eleventh and twelfth) are encountered _ and at least the larger nerve branch should be saved.

The margins of the wound are now retracted _ the cecum and appendix located _ and the latter brought into convenient position for the necessary manipulations _ which are those already described under the intramuscular operation, as to ligation of the appendix, its division, and invagination of its stump within the cecum _ except that in the cases where it is the Surgeon's habit to employ the intramuscular type of operation to the simpler cases, and the present operation to the more complex cases, the likelihood of encountering difficulties and complications are considerably greater in the present form of operation.

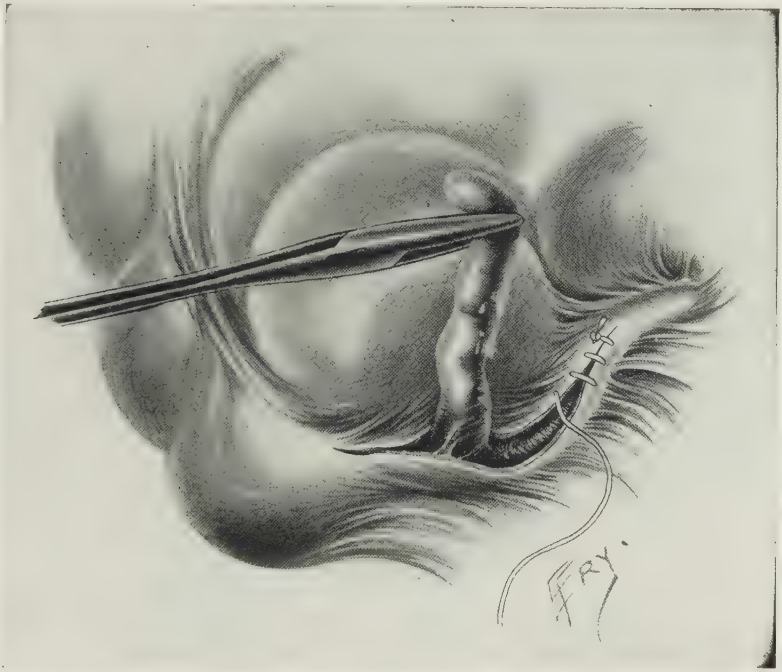


Fig. 4024.—The Dissection of an Adherent, Embedded Appendix _ with the Suturing of the Peritoneum over its Denuded Bed.

Often, in this category of cases, the appendix may be so buried by adhesions as to be very difficult to deliver into the wound _ particularly if it be posteriorly placed. In ligating the base of the appendix it is always desirable to remove the portion of the structure distal to the site of ligation _ and sometimes this is only accomplishable by incising the adhesions overlying the buried tube, and literally digging it out of its bed _ as indicated in Fig. 4024. When this is done the bed from which it is removed should be sutured. In other instances even this is hard to accomplish, and in some cases of awkwardly placed appendices, especially where there is no question of infection in the remaining portion of the tube (which, indeed, may have had its lumen obliterated) one may be warranted in doubly ligating the appendix near its base, and then simply dividing the structure – leaving the distal portion undisturbed – and treating the stump in the usual manner by invagination.

In cases not requiring drainage the abdominal wound is usually closed by three tiers of sutures – the lowermost, chromic catgut, of the peritoneum, subserous areolar tissue, and posterior rectal sheath, – the middle, silk, of the anterior rectal sheath and external oblique aponeurosis, – and the outermost, silk or silkworm filament, of the fascia and skin.

OPERATION FOR SUPPURATIVE APPENDICITIS WITH INFECTIVE PERITONITIS OR INTRAPERITONEAL ABSCESS

Description.—In this type of cases operation is not only directed against the cause of the condition, the appendicitis – but especially against its consequences, infective peritonitis or abscess, or both. The longer an appendicitis may have been in progress before operation, the more complicated is the case apt to be. The peritonitis may be found to be infective, without pus formation, or already fibrinopurulent, and may be localized or diffused. An abscess may be limited to the region of the appendix, and in communication with a ruptured appendix – or the abscess may be at some distance from the appendix – or the abscess, originating in the neighborhood of the appendix, may extend for some distance from it, and be either in connection with it or isolated from it by adhesions.

These are conditions which are to be regarded as likely to be encountered in intermediate and in late operations.

Preparation – Position – Landmarks.—As in operating upon the non-suppurative type of appendicitis (v. p. 785).

Method of Exposure.—The method of approach usually adopted, where it is expected that suppurative appendicitis or abscess will be encountered, is through the Battle incision – the vertical incision over the outer third of the right rectus (v. p. 799) – as more leeway is thereby offered, to meet the difficulties likely to be encountered, both in the way of retracting the margins of the wound and of extending the ends of the wound. The intramuscular type of operation may have been undertaken not expecting to find complications of this sort – or may have been undertaken as a routine – when, to gain the necessary room, the Weir extension of this incision (v. p. 125) may be required.

Operation for Suppurative Appendicitis with Localized Peritonitis.—On opening the peritoneal cavity in the usual manner, free seropurulent, or fibrinopurulent fluid may escape from the wound – fluid which, up to the time of the incision, has been restrained by adherent peritoneal barriers from general diffusion. To avoid traumatism to the peritoneum, as well as to avoid breaking down adhesions which may still be very frail, the best method of removing this infective peritoneal fluid is by suction drainage. In the absence of the necessary apparatus for this method of drainage, the fluid should be carefully absorbed upon dry gauze pads. The regions should then be packed off with taped-and-clamped towels which have been wrung out in hot normal saline solution. After this one proceeds to remove the appendix in the usual manner – except that it is to be remembered that appendices, in this class of cases, are apt to be very friable, or actually perforated, and sometimes gangrenous. As they are often riddled with infective bacteria, they should be wrapped in gauze, while being handled, to avoid unnecessary dissemination of these bacteria. Such appendices often go to pieces under handling – especially by crushing, and are often cut by the ligature. Having completed the details of the operation proper, the weighty question of drainage arises. In the simpler cases, with a small amount of fluid, with no or but little suggestion of purulency about the fluid, with peritoneum but little congested, with definite circumscription of the process, and the appendix not having given away, there arises some warranty of closure without drainage – and this course is actually often, though not invariably, adopted by many good Surgeons. Such action is a matter of personal judgment in specific cases. It must, however, be acknowledged that at least temporary drainage, with a cigarette-drain, for twenty-four or forty-eight hours, is a safer régime. Certainly if there be any reasonable doubt (and there probably will be in the majority of cases), one should err on the safe side, and drain. Such drainage is indicated in Fig. 4025.

Operation for Suppurative Appendicitis with Diffused Peritonitis.— In these cases there are no recognized, walled off limitations to the generalized peritonitis which has resulted from the suppurative appendicitis – and there are no localized abscesses. The proportion of purulent element present in the infective peritonitis will differ in individual cases. The chief indications in these cases are the expeditious removal of the appendix and the institution of drainage. The abdomen is best opened by the Battle incision, through the outer third of the right rectus muscle. On entering the peritoneal cavity, the peritonitic fluid is more satisfactorily removed by suction drainage, or if this be unavailable, by absorption upon gauze pads. While it is indicated to avoid unnecessary distribution of infection, the same extreme necessity does not exist as in the localized form of infective peritonitis – for here diffusion of the process has already occurred before the abdomen is opened. It is in cases of diffused peritonitis that irrigation of the peritoneal cavity was once so generally employed – and, in some quarters, the method is still in vogue – and it may be said that where the fouling of the peritoneal cavity is extreme, and the infection general and intense, it can hardly be distributed

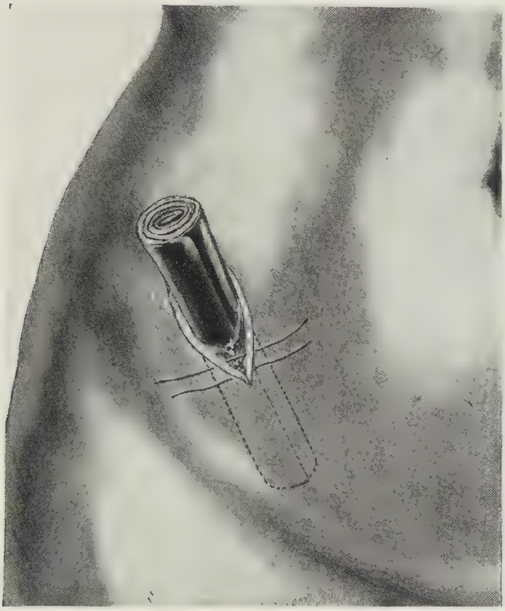


Fig. 4025.—Cigarette Drainage of the Appendical Region in Localized Peritonitis.

further, or made worse, by a quantity of warm, normal saline solution, delivered with an irrigator, or poured in from a pitcher _ and, indeed, may very reasonably be made better thereby. But, nevertheless, freeing the peritoneal cavity by very careful dry sponging with gauze pads is employed by the majority of Surgeons. The delicate peritoneum, however, must not be traumatized by rough handling and gauze scrubbing, which would handicap its further usefulness in combating the infection _ and eventration should be avoided.

Having disposed of the peritonitic fluid, the site of operation upon the appendix itself is reasonably packed off with gauze pads or towels, whichever is used being taped and clamped. The appendix is dealt with in the usual manner _ except that, as in the localized form of peritonitis, the structure may be either too friable or too much disintegrated, or the cecum may be too much infiltrated to enable the usual technic to be carried out. Sometimes only a simple ligature can be thrown around the base of the appendix and tied, after which the structure or its remains are excised _ and the stump left free in the peritoneal cavity.

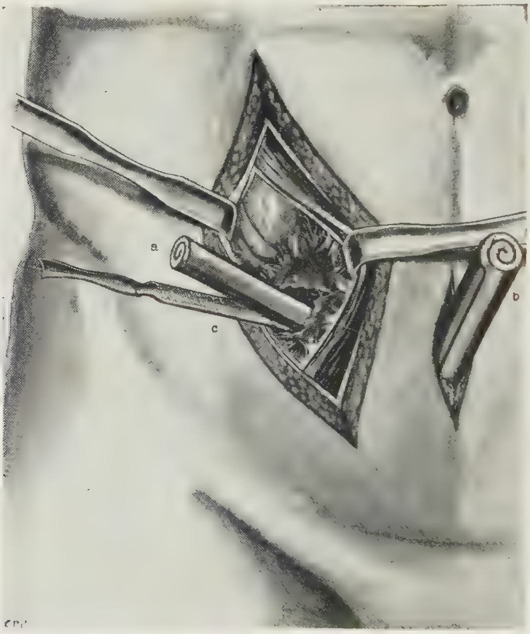


Fig. 4026.—Cigarette Drains of the Appendical and Midpelvic Regions in Diffused Septic Peritonitis of Appendical Origin: _ **a**, Drain passing between fibrinous deposits and masses of adhesions, to the site of the involved appendix, in the iliac fossa _ guided by a finger or by a blunt dissector or director; _ **b**, a somewhat larger gauze and rubber tissue drain, passing to the pelvic floor, in the median line.

In these cases extensive drainage is of paramount importance _ their fate, indeed, usually turning upon the question of drainage. Ordinarily at least two drains are employed, two large cigar drains, of alternate folds of several layers of gauze, and of rubber tissue _ or large, fenestrated rubber tubes, surrounded by gauze. One of these is carried down past the stump of the appendix to the bottom of the iliac fossa. The other is generally placed directly over the symphysis pubis, above the bladder, into Douglas' culdesac, in women — and to the postvesical space, in men, and carried down to the bottom of the median aspect of the pelvic floor. In the case of females vaginal drainage of the pelvic peritoneum is sometimes instituted. The double drainage, lateral and median, is shown in Fig. 4026. These drains are made much more efficient by placing the patient in the Fowler position — with elevated shoulders — following operation.

Whenever a second drain is used, this is usually introduced through an incision made over a finger or an instrument, carried through the original incision made to expose the appendix.

Before concluding the operation and introducing the drains, one should be reasonably certain — in dealing with both localized and diffused peritonitis — that no hidden, walled off abscess is left behind — either in the immediate vicinity of the appendix or more remote from it. Finally, the abdominal wounds are sutured up to the exit of the drains.

Operation for Suppurative Appendicitis with Associated Abscess of the Appendical Region.—In these cases an abscess, of appendical origin, is found in immediate relation with the appendix, or its remains, on opening the abdomen — and more or less localized to its vicinity — the rest of the intraperitoneal cavity being free of infection and walled off. The twofold question comes up, as in most of these cases — of removing the appendix and of draining the abscess cavity — and to accomplish both without breaking into the general peritoneal cavity. It is ideal to accomplish these three ends, if it be possible, with safety to the patient. Drainage is imperative — but frequently no attempt can be made to remove the appendix — so that one of two alternatives must usually be chosen — after removing the pus by suction drainage, or gauze mopping.

One may attempt to remove the appendix in the technical manner or in some compromise way (such as mere ligation and excision, without inversion) — and then establish drainage. At the beginning of the operation the peritoneal cavity is walled off — and it is of first importance, in subsequent manipulations, to preserve this natural barrier. With this uppermost in mind, one may proceed to try to disengage and deliver into the wound the offending appendix. This may sometimes be accomplished with surprising facility. When the appendix is but little, or not at all adherent, this may be an easy matter — and it may even sometimes be possible to accomplish the technical inversion of its stump by purse-string suture after excision. But in the majority of cases of this category, if the appendix can be delivered at all, it is usually after bluntly dissecting it from the midst of more or less extensive adhesions. And in many such cases the most that can be accomplished in appendices thickened or stiffened by infiltration, or partly disintegrated by necrosis, is the simple ligation of the base of the structure and the excision of the distal portion, without attempting to invert the stump — followed by the establishment of drainage. It is distinctly unwise, on the other hand, to carry one's attempts to deliver, ligate, and excise the appendix so far that, in the enthusiasm of the endeavor to technically complete the undertaking, the barrier wall of adhesions, protecting the general peritoneal cavity, is broken down. Such a course would be unwarrantable (though formerly much practised) even if it were not known (as a matter of comfort to the Surgeon) that very many of such appendices as furnish these complications have already been practically destroyed by the pathologic processes in action, their lumina often sealed, and their remnants rendered innocuous for future harm — it being decidedly exceptional when a secondary appendicitis subsequently occurs in these cases — though the appendix be left.

The second alternative is often the wiser one in this class of cases, namely, to simply open the abscess cavity, in the act of incising the abdominal wall by the Battle incision over the outer third of the right rectus _ and insert a cigarette or cigar drain down to the bottom of the appendical abscess, with its lower end in contact with the base of the appendix and draining the bottom of the cavity. No attempt is made to remove the appendix itself _ unless upon the simplest, gentlest examination it be found that this may readily be done without breaking into the peritoneal cavity. The appendix or its remains will often come away in the subsequent drainage _ or, if it does not, is more than apt to be rendered harmless in the subsequent scar contraction. Where the lumen of the appendix is still patulous, fecal matter may escape for a few days during drainage, but generally ceases of its own accord.

The Author was very much impressed at repeatedly witnessing Sonnenburg's rapid and simple technic in this type cases, where it was a common thing for several to be disposed of within the hour _ the abscess being merely incised and packed with gauze, as one would an abscess of the thigh, without manipulation of any kind within the wound _ and the table cleared for the next case _ ten minutes seeming to cover the whole proceeding, as well as can be remembered.

OPERATIONS FOR ISOLATED ABSCESSES OF APPENDICAL ORIGIN ADJACENT TO OR REMOTE FROM THE APPENDIX

Description.—Abscess of appendical origin, immediately contiguous with, and as a result of, suppurative appendicitis, has just been described. Under the present heading will be considered isolated abscesses which have had their origin in infective appendicitis, and in which the process of infection has been disseminated from this origin to nearby or to distant regions, and have been there walled off by adhesions and by other processes as localized abscesses.

Chief Varieties of Isolated Abscesses of Appendical Origin.—(*a*) Retrocecal _ (*b*) retrocolic _ (*c*) iliac (chiefly right) _ (*d*) pelvic _ (*e*) presacral _ (*f*) lumbar (chiefly right) _ (*g*) subumbilical _ (*h*) interintestinal _ (*i*) subhepatic _ (*j*) perisplenic _ (*k*) subphrenic.

The position of the abscess of appendical origin is determined by a variety of circumstances, such as the position, length, and direction of the appendix _ anatomic conditions determining the direction of spread of infection (as the planes of intraperitoneal fluid communication, the lines of attachment of the mesenteries, the troughs formed by the mesenteric leaves, and the like) _ and the dissemination by active lymphangitis, and by venous blood channels.

The method of handling some of the most frequently occurring varieties of abscess will be considered.

It may be said, as a matter of generalization, that these localized abscesses naturally group themselves into two classes, _ those which have one of their walls so bounded by some part of the abdominal parietes, that it may be reached through this wall without entering the general peritoneal cavity, _ and those which are so situated that they cannot be readily or safely reached without passing through a part of the free peritoneal cavity. Another broadly applicable generalization is, that, as a rule, where these abscesses show, by phenomena of the abdominal parietes, a tendency to "point," that site is usually the best to select for incising them.

(**1**) Operation for Abscesses Which May Be Opened Through the Abdominal Wall Without Traversing the Free Peritoneal Cavity: This technic is well illustrated in the case of a subphrenic abscess of appendical origin. The incision is here made through a lower intercostal space (or after excising part of a rib), below the reflection of the pleura.

(2) Operation for Abscesses Which May Be Opened Through the Abdominal Wall Without Draining Through the Peritoneal Cavity – After Having First Located the Abscess Through an Intra-abdominal Opening, Which is Then Closed: In some cases where abscesses are strongly suspected, but where no corroborating evidences are otherwise obtainable, a routine often pursued, and wise in principle, is to open the abdomen by median or paramedian incision for the purpose of locating and circumscribing the abscess – and then, while the abdomen is still opened, and guided by the hand within the peritoneal cavity, to incise the abdominal wall at the most desirable site, as thus ascertained, and enter the abscess by an extraperitoneal route – evacuating its contents, examining the nature of the abscess, by combined investigation from within and from without, and then instituting drainage – after which the main abdominal wound is closed – and the minor wound used for drainage. Of course, during such a procedure, unusual care must be exercised against infection of the general peritoneum from the pus cavity. The course just recounted may be carried out in the case of an abscess not suspected, but accidentally discovered in the course of an intra-abdominal operation.

(3) Operation for Localized Abscess Which Must Be Approached and Drained Through the Free Peritoneal Cavity: It will often happen, in the course of intra-abdominal manipulation, in this class of cases, that an isolated, walled off abscess is discovered which admits of no possibility of being drained except through and across some part of the free peritoneal space. In such cases it becomes necessary to wall off the site of involvement with thoroughness and care from the rest of the peritoneum, by means of gauze pads, taped and clamped. The pus cavity is then carefully emptied in such a way as to avoid an out-gush of pus, with almost inevitable soiling beyond the extent to which it may have been prearranged to guard. The emptying of such cavities by suction drainage is generally very satisfactory – the tube entering through a small incision, which it at the same time blocks – and, by suction, gradually lessening the tension until there is no tendency to outflow. In the absence of this apparatus a small incision is first made, and the escaping pus at once caught upon gauze before it has spread far enough to soil. Eventually, the cavity is further incised, and thoroughly cleansed and dried by gauze mopping. Finally, when all pus soiling has been wiped away from the abscess bed, and any soiling of the intestines removed by wiping with gauze wrung out in normal saline, a substantial cigarette or cigar drain is introduced to the very bottom of the cavity, and brought out of the abdominal wound, which is sutured up to its exit.

(4) Operative Treatment of Pelvic Appendical Abscesses: Owing to the depth of the pelvis, and to the position usually assumed by abscesses within its limits, these abscesses, while they admit of being evacuated and drained through the abdominal wall, do so somewhat against gravity. Drainage through the abdominal parietes is often resorted to alone – though frequently the abdominal drain constitutes but one of two drains simultaneously used – for instance, either as the accompanying and additional drain to the one placed in the region of an excised appendix – or as the counterdrain to one passing outward through some part of the floor of the pelvis. When a pelvic abscess is drained from below, the opening is made in some part of the middle line of the body. In a woman whose vagina is not obstructed by a hymen (and this may be sacrificed), the usual method of procedure (in draining from below) is to make an opening through the dome of the posterior vaginal fornix (Douglas' culdesac) – which is accomplished by retracting the posterior vaginal wall, grasping the cervix and drawing it downward and out-

ward, and transversely or vertically incising the posterior vaginal dome, until the peritoneum is exposed, and then seizing and incising this – following which a rubber tube, of fair caliber, and long enough to extend outside of the vaginal outlet, is introduced, and steadied in position by the dressings at the outlet. In males and in young girls the rectum is often used for single or for counter-drainage. The anus having been dilated, the rectal walls are held apart by retractor, or special speculum, and the site of the bulging abscess, determined by touch or sight, or both, is incised. The incision is made through the anterior wall either in one act, or incision is made part of the way and the rest of the opening made by blunt dissection, or by the Mayo scissors, or by forcing in a pair of dressing forceps and then separating their blades. Finally the opening should be made ample for drainage – but no form of mechanical drain is employed which would be apt to increase the facility with which feces would enter. The idea of using the rectum for the purpose naturally goes against the grain on the score of possible infection from bowel contents. And the stab-in-the-dark feature of making openings through both the vaginal fornix and the anterior rectal wall are not ideal surgical procedures – but practical experience has established the usefulness of both technics in certain cases. Failure to reach pus and wounding of the bowel have been recorded against the rectal drainage. These methods typically represent gravity drainage.

In some instances pelvic abscesses are drained through the free pelvic peritoneal cavity – the procedure being accomplished in the same manner as described above (under No. 3), the drain usually making its exit just above the symphysis.

It is quite another matter, and altogether a safer and more to be recommended technic, to institute drainage through either the vaginal fornix or through the anterior rectal wall, provided the abdomen has been first opened – for then damage to other structures, especially to coils of intestine, can be safeguarded against under sight and touch – after having investigated the conditions of the abscess and surrounding parts. The lower drainage is then established while the abdomen is opened – but the abscess focus is not opened or drained from above at all, the abdominal wound being closed entirely.

(5) Operative Treatment of Retrocolic Abscesses: When these abscesses first start they can be reached by a vertical incision in the right lumbar region over the course of the ascending colon. When they have extended to the upper limit of the retrocolic region they are to be treated as subphrenic abscesses.

(6) Operative Treatment of Subhepatic Abscesses: These upward extensions of infection from the retrocecal region, along the external or posterior aspect of the ascending colon, are best reached by an incision below and parallel with the twelfth right rib, in the loin. One should progress with care, as the incision may either reach the pus without opening the free peritoneal space, which would be especially fortunate – or the peritoneal cavity, unshut off by adhesions, may be at once invaded. In the latter event the conditions should be recognized in advance of incising the abscess, and if this be unprotected by adhesions, the general peritoneal cavity should be packed off with gauze in advance. A large rubber tube surrounded by gauze is inserted as a drain.

Sometimes a subhepatic abscess is associated with a subphrenic one – when both may often be drained through the same wound – one tube passing above and the other below the liver.

(7) Operative Treatment of Subphrenic Abscess: Sometimes subphrenic abscesses may be opened subpleurally in the midaxillary line (between the

tenth and eleventh, or between the eleventh and twelfth ribs) _ but the usual method is to operate transpleurally, through the posterior aspect of the chest, after excising a portion of the eighth, ninth, and tenth ribs. If the pleural cavity be found open (although often found obliterated at the site), the parietal pleura is sutured to the diaphragm, before incising the latter. On incising the diaphragm, if the peritoneal cavity be not closed off by adhesions, the general cavity should be protected by gauze packing, before opening the abscess (that is, in those cases in which the incision does not come down directly upon the site of abscess). The diaphragm should be sutured to the chest wall, so that, as the phenomena subside, with the evacuation of pus, the diaphragm will not be torn away from its possibly weak adhesions, and thus allow infection to be spread. Free drainage by tube should be established.

(8) Operative Treatment of Perisplenic Abscesses: These are usually extensions upward along the outer aspect of the descending colon from pelvic pus infections _ and are to be treated in a way similar to corresponding perihepatic involvements _ either by transpleural or left lumbar incision.

CECOSTOMY

Description.—Cecostomy, or typhlostomy, is a form of enterostomy in which the cecum is chosen as the site of opening the intestine in communication with the surface. This may be accomplished by means, preferably, of a rubber tube carried through an opening in the cecum after the manner of either a Witzel or a Kader gastrostomy _ or by anchorage of the cecum in the wound after the fashion of an ordinary colostomy.

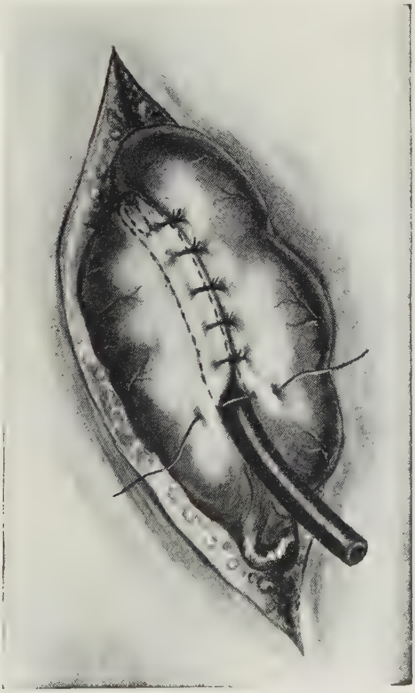


Fig. 4027.—Cecostomy by the Witzel Method of Burying a Rubber Tube.

The opening is usually meant to be temporary, and is generally resorted to as a transient measure in local conditions of the ascending or transverse colon _ especially where it is necessary to drain the first part of the colon, in malignancy, or irrigate it, in colitis, or to relieve abdominal distention. It has already been spoken of as an alternative to appendicostomy.

The operation has the considerable disadvantage that the contents of the cecum are fluid and irritating, so that the abdominal skin in the neighborhood is due to be constantly excoriated by the discharge. And it is among the possibilities (though unsettled) that the loss of nutrition through such an opening may be harmful.

Preparation _ Position _ Landmarks _ Incision.—The same as those for appendicectomy (v. p. 785) for the intramuscular operation, and p. 799 for the open operation.

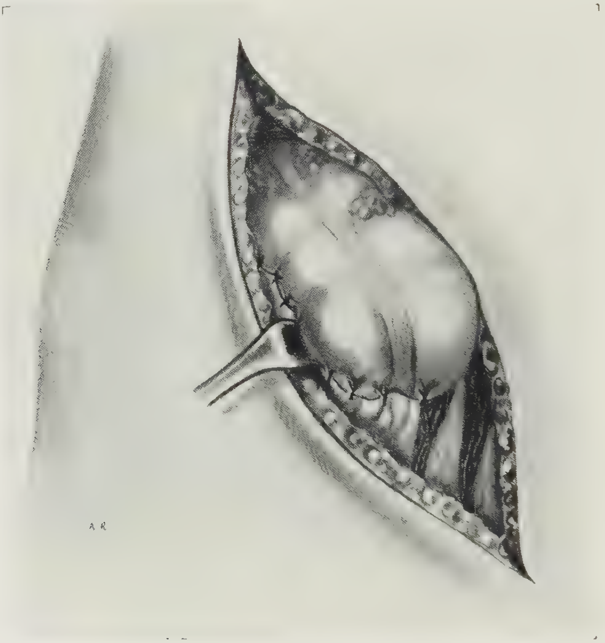


Fig. 4028.—Cecostomy by Anchorage of the Presenting Cecum in the Abdominal Wound _ to be followed by incision of its wall.

Operation.—Some Surgeons prefer to expose the cecum and institute cecostomy by the intramuscular method of approach _ while others prefer to do so through an open incision made vertically through the outer part of the right rectus _ or after displacing the rectus inward, after incising its aponeurosis. The method of exposure will depend somewhat upon the object sought in the special case. The cecum is ordinarily readily encountered as soon as the abdomen is opened through the incision which lies directly over it. A distended cecum may immediately bulge into the wound. Having delivered the free aspect of the cecum into a convenient position for manipulation, the opening into its cavity may be accomplished in several different ways:

Cecostomy by the Kader method of invaginated rubber tube _ in which the tube is surrounded by a series of non-penetrating concentric purse-string sutures – each being applied and tied in turn, as in Kader's gastrostomy, after which the cecum is sutured into the abdominal wound.

Cecostomy by the Witzel method of burying a rubber tube obliquely through the wall of the cecum (Fig. 4027) – followed by the suturing of the cecum into the abdominal wound.

Cecostomy by anchorage of the presenting portion of the cecum in the abdominal wound as in ordinary colostomy (q. v.). The anchorage is made into the lower plane of the wound, as the opening is intended to be but temporary (Fig. 4028).

CECOPEXY

WILMS' OPERATION

Description.—Abnormal mobility of the cecum is sometimes encountered – especially in volvulus of the cecum – and the operation of anchorage, or fixation, constitutes the operation of cecopexy.

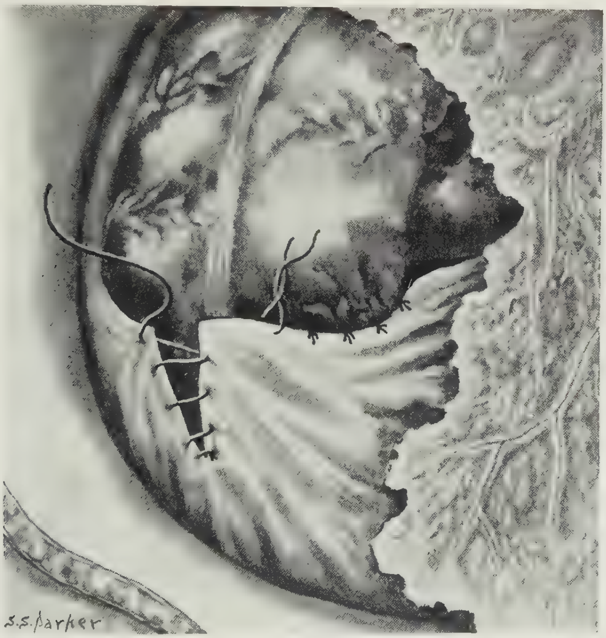


Fig. 4029.—Cecopexy – Wilms' Technic; – The formation of a right-angled, retroperitoneal flap pocket, upon the postero-external iliac wall, for the reception of the displaced cecum. The vertical slit thus made is sutured – and its horizontal portion is stitched to the cecum with chromic catgut.

Operation.—In Wilms' method of fixing the mobile cecum the abdomen is entered by an incision in the neighborhood of the right anterior superior iliac spine. The appendix is first removed as in ordinary clean appendicectomy. In the bed where the cecum normally lies – but which has been more or less vacated by the loosened and wandering viscus, a retroperitoneal pocket is formed against the wall of the right iliac fossa for its reception and anchorage. This is accomplished by displacing, inwardly and upwardly, the interfering coils of intestine, including the ileocecal junction – after which an angular incision is then made through the parietal peritoneum, of the form shown in Fig. 4029, and bearing the relationship to the restored cecum (from which the appendix has been excised) indicated therein. This incision is placed behind and to the outer side of the cecum, against the postero-external iliac wall. The right-angled flap of parietal peritoneum is then freed by blunt dissection, in the connective-tissue plane, sufficiently to accommodate and support the lower aspect of the cecum _ which is now placed within its confinement. Finally, the vertical portion of the peritoneal incision is sutured with silk to complete the pocketing. It would also seem wise to place a few interrupted chromic catgut sutures, attaching the horizontal edge of the flap to the cecum, especially to the longitudinal band of the cecum _ being careful not to penetrate the cecum. Adhesions eventually hold the viscus in place. The abdomen is closed as usual.

CECECTOMY, WITH EXCISION OF THE ADJACENT PARTS OF THE ASCENDING COLON AND ILEUM, FOLLOWED BY ILEOCOLOSTOMY

Description.—Excision of the cecum, together with the immediately adjacent portion of the ileum and more or less of the ascending colon _ followed by either a lateral, terminolateral, or end-to-end ileocolostomy. The operation is often termed "ileocecal resection." The operation is most frequently performed for malignancy of the ileocecal tract and of the ascending colon _ and sometimes for tuberculosis and for intussusception. Usually but a few inches of the terminal end of the ileum is removed _ and, as a rule, not more than the lower portion of the ascending colon, though sometimes the entire ascending colon is excised. The amount of the intestinal tract removed will depend, of course, upon the kind and degree of involvement. And the form of subsequent anastomosis made between the end of the ileum and some part of the colonic tract will depend upon the special circumstances of the case and the views of the individual operator. Also see Intestinal Exclusion, p. 757. The operation which will be here described will be the excision of the last 15.2 cm. (6 inches) of the ileum, the cecum, and the beginning of the ascending colon _ followed by closure of the ends of the ileum and ascending colon _ and the lateral isoperistaltic anastomosis of the ileum with the middle, approximately, of the transverse colon. The removal of the lymphatic vessels and glands of the region involved is of paramount importance.

Preparation _ Landmarks.—As for Appendicectomy, p. 785.

Position.—The patient lies with his right side near the edge of the table, and with this side of his body and his right buttock slightly raised _ thus aiding the small intestines to gravitate away from the field of the operation. A moderate Trendelenburg position of the table further aids to these ends.

Incision.—This is made vertically over the outer part of the right rectus muscle _ and is usually from 12.7 to 15.2 cm. (5–6 inches) in length _ according to the thickness of the abdominal wall and the circumstances of the special case. Other incisions are also employed _ sometimes in the right semilunar line _ and, again, the incision has been made in the anterior axillary line (a vertical line from the anterior border of the axilla), beginning midway between the lower margin of the costal cartilages and the iliac crest, and passing downward to within about 4 cm. ($1\frac{1}{2}$ inches) of the anterior superior iliac spine, and thence running downward and forward, parallel with the outer half of Poupart's ligament, to end at the outer side of the position over the external iliac artery. While regard for the strength of the resulting abdominal wall should be had, the desperate circumstances under which this operation is usually performed (malignancy) makes all considerations secondary to such free exposure as will give the best chance for the radical removal of all diseased tissue.

Operation.—The chief difficulty to be encountered, in the operation as a whole, is the freeing and delivering of the ileocecum, owing to its relative immobility and absence of free mesentery. It is usually planned to divide the ileum about 10 cm. (4 inches) from the cecum _ and the operation is begun, after protecting the field by gauze pads, and retracting these by the ligation of the mesentery of this portion of the ileum (Fig. 4030). Two silk or linen ligatures are carried around the ileum, immediately to each side of the site to be divided, and tied tightly _ after which the ileum is divided between them by knife or cautery. Nothing further is done to the distal end of the ileum (except to protect it from soiling the field by clamping a piece of gauze about it, or by a modified form of invagination, for temporary protection only, until the whole mass comes away). The ligated proximal end of the ileum, however, is invaginated within the ileum by a purse-string suture of silk _ which may be reinforced by a second purse-string suture or by a few Lembert stitches.

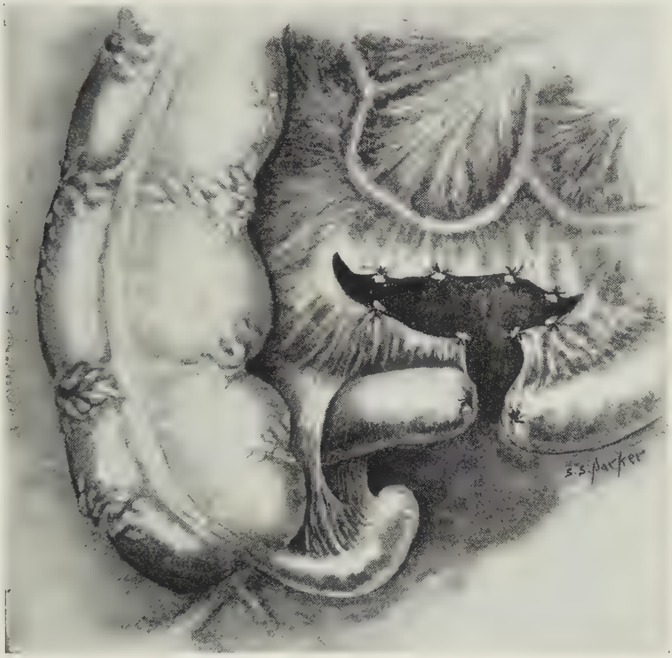


Fig. 4030.—Cecectomy, Followed by Lateral Isoperistaltic Ileocolostomy _ I; _ Ligation and division of the mesentery of the end of the ileum, and division of the ileum.

The free, proximal portion of the ileum is now brought into such isoperistaltic relation with the transverse colon at, approximately, the middle of the transverse colon, that its antimesenteric aspect can be laterally anastomosed with the tenia of the transverse colon. The details of the anastomosis are those usually carried out.

The cecum is now to be separated from the iliopsoas fascia upon which it lies. This is accomplished by displacing the cecum and ascending colon inward, and cutting through the peritoneum as it is reflected along the outer aspect of the cecum and colon, where it binds these structures to the posterior abdominal wall _ ligating any vessels which are severed. but none ordinarily require ligature along this peritoneal reflection.

The cecum and lower part of the ascending colon are then drawn forward and temporarily displaced to the inner side to investigate the retroperitoneal areolar tissue bed from which these structures have just been divided on their outer side. Important structures are encountered upon the postero-internal aspect of the cecum and ascending colon which must be carefully guarded. The right spermatic vessels must not be injured as they cross the ureter from above and within, downward and outward _ and particularly must the ureter not be harmed as it crosses the psoas major muscle obliquely, from above and without, downward and inward, beneath the spermatic vessels. In the upper aspect of this retroperitoneal bed, if the parts be well retracted inward and upward, the lower pole of the right kidney, and the lower and outer part of the duodenal horseshoe are exposed. Thus forewarned of the structures to be safeguarded, the mobilized cecum and lower part of the ascending colon are now displaced outwardly, and the reflection of peritoneum along the

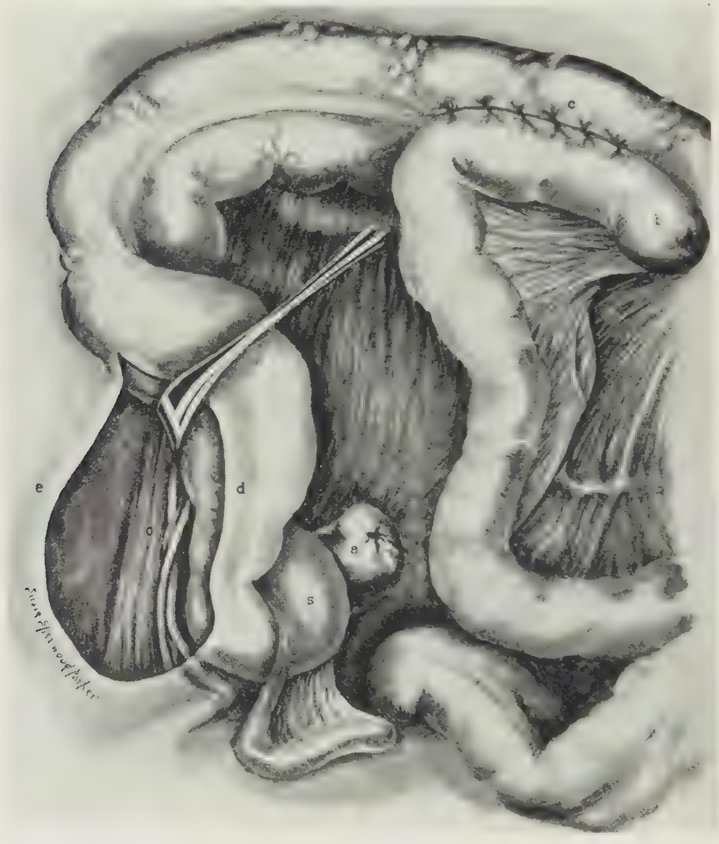


Fig. 4031.—The Same _ II; _ A lateral isoperistaltic anastomosis is made between the antimesenteric aspect of the free end of the ileum and the anterior muscular band of the transverse colon near its middle. The outer peritoneal reflection of peritoneum has been divided along the cecum and lower part of the ascending colon, and these structures have been displaced upwardly and inwardly _ revealing the bared retroperitoneal areolar tissue bed. The ureter is seen crossing the psoas major _ and the spermatic vessels are seen crossing the ureter. **a,** Distal end of the ileum, invaginated; _ **b,** its proximal end; _ **c,** ileocolonic lateral anastomosis; _ **d,** mobilized cecum and ascending colon, being displaced inward; _ **e,** opposite margin of the incised parietal peritoneum.

inner side is divided _ but on this side the colonic vessels are encountered as they diverge to supply the cecum and ascending colon, so that the mesentery along the inner border is ligated in sections and divided as one proceeds _ especially guarding the ureter as the ligaturing and division extend toward the upper limit of the site of excision.

Having thus freed the cecum and part of the ascending colon, they are drawn upward and inward (Fig. 4031), and the contents of the large bowel are pushed distally, by compressing the walls with the fingers, and two silk or linen ligatures thrown around the portion of the ascending colon where it is to be divided _ and after tying these ligatures the colon is divided between the ligatures, with the actual cautery or scissors _ with every precaution to prevent soiling. This enables the ileocecocolonic portion of intestine which has been excised to be removed from the field.

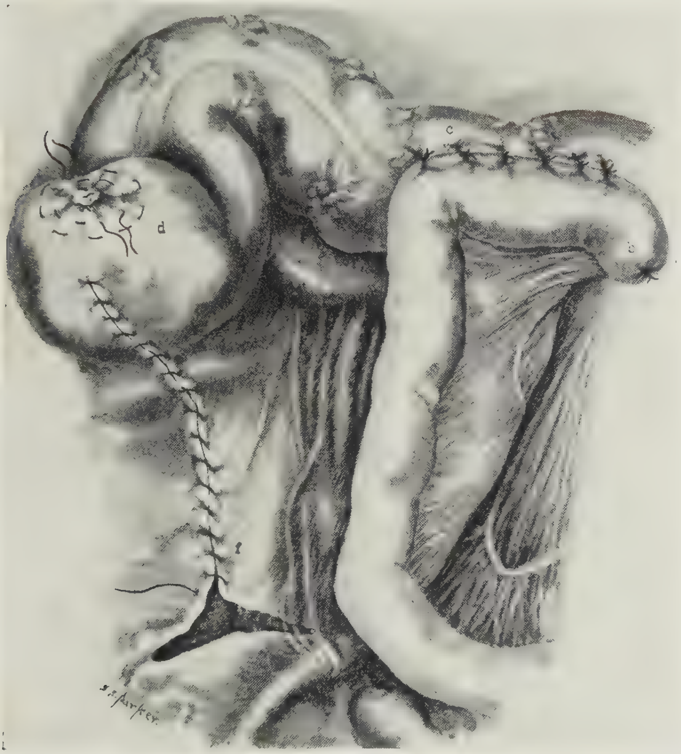


Fig. 4032.—The Same _ III; _ The lower end of the ileum, cecum, and beginning of the ascending colon have been entirely freed, drawn outward, and excised. The distal end of the colon has been ligated, and is being incised, **d.** The bed formerly occupied by the ascending colon is being closed, as far as possible, by suturing together the opposite margins of the parietal peritoneum, **f**; **b,** distal end of the divided ileum invaginated; **c,** site of ileocolonic anastomosis.

The margins of peritoneum bounding the now raw retroperitoneal bed, as well as the posterior aspect of the part of the ascending colon left in the wound (Fig. 4032), are now brought together by sutures as well as it is possible _ endeavoring to cover the retroperitoneal bed, and the outer aspect of the entire circumference of the end of the ascending colon with peritoneum _ after which at least two tiers of successive purse-string sutures of silk or linen are placed about the free end of the ascending colon, so as to invaginate the ligated end at least twice. A row of Lembert stitches may take the place of the second purse-string suture _ or may follow the second purse-string suture. Unusual care is expended in making the closure of the end of the colon satisfactory.

The abdominal wound is usually closed without drainage _ but in those cases where temporary drainage, after such an extensive operation is considered desirable, this is generally best accomplished through a stab-wound in the loin.

Comments.—Jamieson and Dobson emphasize the fact that although the tendency of the lymphatic vessels coming from the ileocecal segment of the bowel is to end in the nearest glands, yet many of them drain into the upper and lower groups of the main ileocolic glandular chain _ so that deposits may occur as far away as the beginning of the ileocolic artery _ and that, therefore, the upper ileocolic glands should also be removed _ and that the ileocolic vessels around which these lymphatic vessels and glands are intimately connected should be ligated and divided near to their parent stems _ but safeguarding the blood-supply to the portions of the intestine just proximal to the division of the ileum and just distal to the division of the ascending colon.

In this connection see Excisions of the Colon, in General (v. Index, Vol. IV).

If the lowest ileocolic vessels are cut or damaged the first 15.2 cm. (6 inches) of the ileum lose their chief blood-supply.

The liver should be examined, by palpation, when the abdomen is opened, for secondary deposits _ before proceeding with the operation.

The ileocecal segment of the intestine may be so largely involved and so adherent to the abdominal wall and to other coils of intestine as also to forbid the continuation of the operation.

It is to be noted that if the ileocolic artery is ligated near enough to its origin to include the right colic artery, then practically all of the ascending colon must be excised _ that is, as much of the large intestine as is supplied by the arterial branch that is sacrificed.

LEOCECAL EXCLUSION WITHOUT INTESTINAL RESECTION

In some cases of inoperable tumor it becomes necessary to exclude the ileocecal segment of the bowel from fecal circulation _ without undertaking to remove this segment. This subject, and the technic of its performance, have been described (v. p. 757).

It is of very practical importance to remember that if the ileocecum be excluded, and left *in situ*, this short-circuited portion should be connected by a fistulous outlet (an enterostomy opening) with the skin _ as a safety valve

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